NOV 12 1931

Engineering and Mining Journal

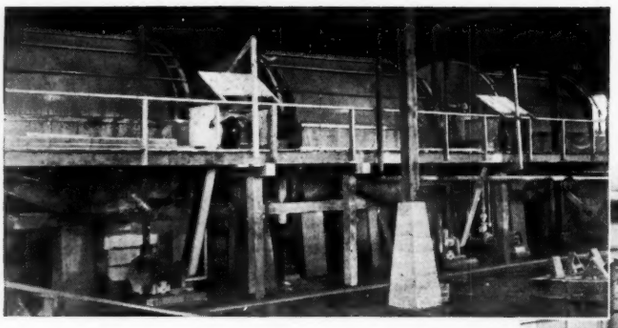
McGraw-Hill Publishing Company, Inc.

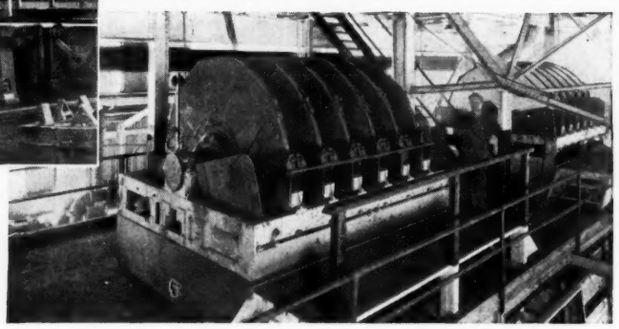
Price 25c. per copy

Moving a pumping unit at a Florida phosphate pit

November 9, 1931

Cyanidation or Flotation—





Oliver Uniteds for Filtration . .

CYANIDE mills in all parts of the world are operating Oliver United Filters to wash all but a trace of gold from the cake before discharge. Oliver Uniteds not only do a thorough job of washing but they actually help to increase extraction through aeration on the filter. Gold producers, interested in cyanidation of flotation concentrates, will find Oliver United Filters equally adaptable to this process as they are to "straight" cyanide plants.

In flotation plants—lead, copper, zinc, etc.—Oliver United units have long demonstrated their ability to filter concentrates, producing a dry cake in good condition for transfer or shipment to the smelter. In selective flotation plants of moderate size, one American Filter with divided tank can handle the two or three concentrates at the same time.

No matter what kind of mill you are operating, no matter what kind of ore you are milling, no matter how large or how small your plant is, you will find an Oliver United Filter unit suited to your own filtration needs.

OLIVER UNITED FILTERS INC.

SAN FRANCISCO
Federal Reserve Bank Bldg.

NEW YORK
33 West 42nd Street

PARIS

CHICAGO
221 North La Salle Street

TORONTO
330 Bay Street

LONDON

AGENTS

TOKYO	Andrews & George Co., Inc.	HALLE, GERMANY	Wilhelm Lill
MELBOURNE	Crossle & Duff, Pty., Ltd.	SCHEVENINGEN, HOLLAND and SOERABAJA, JAVA,	Van Lelyveld & Co.
MANILA	The Edward J. Nell Co.		
STOCKHOLM	T. An Tesch	RECIFE, BRAZIL	Ayres & Son

JOHANNESBURG—Edward L. Bateman, Pty., Ltd.

FACTORIES: Oakland, Cal., Hazleton, Pa., Peterboro, England. Cable Address: OLIUNIFILT

Associate Editors
E. H. ROBIE, A. H. HUBBELL
Assistant Editors
W. N. P. REED, H. D KEISER
S. D. STRAUSS, B. H. STROM
Market Editor
H. H. WANDERS

Engineering and Mining Journal

A. W. ALLEN, *Editor*

San Francisco
GEORGE J. YOUNG
Associate Editor
Tucson, Ariz.
JOHN B. HUTTL
Assistant Editor

Publishing Director: H. W. CLARKE
New York

Contents for November 9, 1931

Contents Copyright, 1931, by McGraw-Hill Publishing Company, Inc.

VOLUME 132 . . . NUMBER 9

Editorials 391

Industrial Ministers Turn International . . . On Planning to Secure Economic Equilibrium . . . Power Plants Provide Important Mercury Outlet. . . Road Building, Automobiles, and the Mining Industry . . . The Surface Factor in Grinding Media . . . Advantage of Staple Prices . . . Automatic Processing of Non-Metallics

Mining Copper in Baja California. . ...*M. Bellanger* 394

Quicksilver Metallurgy .....*C. N. Schutte* 398

Copper Resources of Brazil.....*L. F. de Moreas Rego* 401

Dredge-Sluice Efficiency.....*B. W. Bellinger* 403

Salt Mining with Electric Equipment.....*Leo Reid* 405

Platinum Mining in Sierra Leone.....*J. D. Pollet* 407

Consumption of Flotation Reagents..... 409

Limestone Quarrying and Transport.....*M. F. Goudge* 411

Comment, Criticism, Personals....415
Book Reviews 417
Industrial Progress 419
News of the Industry..... .422
Market and Financial News.. ...428
Metal Statistics 433
Mining Share Prices 434
Searchlight Section 38
Professional Directory 40
Advertising Index 42

Cover illustration courtesy Caterpillar Traction Company

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York, U. S. A.
Cable address: "Machinist, N. Y."

CHICAGO, 520 N. Michigan Ave.
SAN FRANCISCO, 883 Mission Street
ENGLAND, Aldwych House, Aldwych, London, W. C. 2

JAMES H. McGRAW, Chairman of the Board
MALCOLM MUIR, President
JAMES H. McGRAW, JR., Vice-Pres. and Treas.
MASON BRITTON, Vice-President
EDGAR KOBAK, Vice-President
HAROLD W. McGRAW, Vice-President
H. C. PARMELEE, Editorial Director
C. H. THOMPSON, Secretary

Published semi-monthly. Price in the United States and possessions, 25 cents (U. S. Currency) per copy; $4 per year. In all other countries, $20 per year—24 issues. Entered as second-class matter, June 20, 1879, at the Post Office, New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A.

Member A.B.P. *Member A.B.C.*

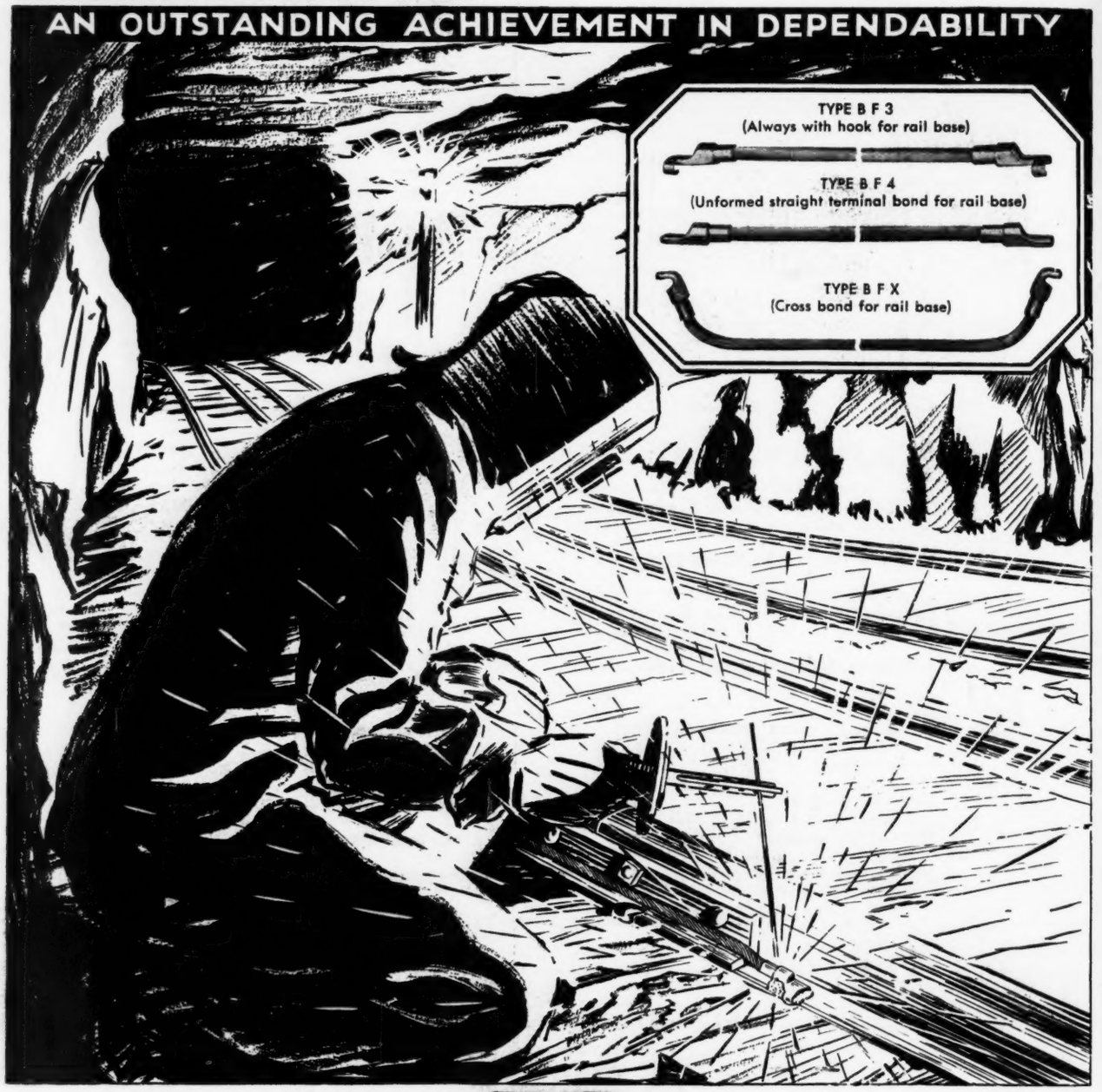
6,800 COPIES PRINTED THIS ISSUE

WASHINGTON, National Press Building
PHILADELPHIA, 1600 Arch Street
CLEVELAND, 501 Guardian Building
ST. LOUIS, 1556 Bell Telephone Building
BOSTON, 1427 Statler Building
GREENVILLE, S. C., 1301 Woodside Building
DETROIT, 2-257 General Motors Building
LOS ANGELES, 339-340 Chamber of Commerce Building

TIGER-WELD
FLASH-BUTT-WELDED
POWER BONDS

THE NEW Tiger-Weld Power Bonds offer economies in application and service that will definitely interest every mine operator. With these bonds, the welder is relieved of the difficult task of welding the wires to the terminal, assuring easier, quicker, more dependable installation. The solid steel terminals greatly facilitate the welding of bonds to the rail. This advanced terminal construction reduces the possibility of transmitting welding heat to conductor, protecting the original high resistance to vibratory stresses, and insuring a longer mechanical life. Full particulars and samples forwarded on request. Address the nearest office.

AN OUTSTANDING ACHIEVEMENT IN DEPENDABILITY


TYPE B F 3
(Always with hook for rail base)
TYPE B F 4
(Unformed straight terminal bond for rail base)
TYPE B F X
(Cross bond for rail base)

1831 — COMMEMORATING 100 YEARS OF PROGRESS IN WIRE MAKING — 1931

AMERICAN STEEL & WIRE COMPANY

208 South La Salle Street, Chicago — SUBSIDIARY OF UNITED STATES STEEL CORPORATION — And All Principal Cities

Pacific Coast Distributors: Columbia Steel Company, Russ Building, San Francisco — *Export Distributors:* United States Steel Products Company, New York

Engineering and Mining Journal

McGraw-Hill Publishing Company, Inc.

November 9, 1931 A. W. ALLEN, *Editor* Vol. 132—No. 9

Industrial Ministers Turn International

FRANCIS BACON, who seems to have preceded Will Rogers by several hundred years in the art of making apt remarks at propitious moments, pointed out that "adversity is not without its comforts and hopes." Two years of adversity have made the task of finding such comforts increasingly difficult, but to the observant are evidences that depression has not been without its blessings, chief of which perhaps is a general improvement in the caliber and tone of thinking. To avoid harsh realities is harder today than it was two years ago. One cannot gloze over a hundred bankruptcies, or lightly dismiss widespread wage cuts.

No better evidence can be obtained to indicate the more realistic attitude of the day than the visits that have recently been made by the political leaders of the great nations to their confrères. Although the advance of science in the last two hundred years has probably had a more important influence on communication than on any other aspect of life, civilization has not yet advanced so that an effective substitute is available for the personal contact of man to man. No amount of cabling or telephoning will replace the advanges inherent in the visit of a Laval to a Hoover or a Bruening to a MacDonald. These visits permit the leaders themselves to obtain a more effective idea of the men with whom they are dealing, but they also serve to call the attention of the public to the problems at issue, to stimulate discussion; and, through discussion, to increase the possibility that effective action can be taken.

A statement has often been made, and rarely disputed, that power today is not localized in governmental agencies. Industrial leaders play as important a part in shaping the destinies of mankind as do their political brethren. For this reason, no matter how cordial the understanding between the statesmen of two nations, effective trade relations cannot possibly exist unless an equally cordial understanding exists between their leading industrialists.

The visits to the United States of Mr. Leslie Urquhart, chairman of the board of Mining Trust, and of representatives of the leading African and European copper producers, occurred simultaneously with that of M. Laval. Mr. Urquhart, as head of the controlling interest in Mount Isa, perhaps the greatest of the world's lead mines, came to cement the contact between his organization and American Smelting & Refining. Together these two agencies plan to cooperate with the London lead cartel in organizing the lead market outside the United States. The copper representatives came to make an agreement as to the part the new Rhodesian mines will play in the copper industry of the immediate future. This should counteract the exaggeration and misstatement in regard to the position of these new African mines characteristic of past publicity. National lines have been drawn, and the press has been given an opportunity to indulge in its favorite game of foreseeing menaces to industrial equilibrium.

The success of Mr. Urquhart's visit is already assured. Regardless of any tangible result reached at the copper conference, a clarification of the issues involved is certain. The men who attended the discussions know more about the copper industry than they did before. One cannot sit at a table and listen to others describe their problems without obtaining a keener appreciation of the issues with which the industry as a whole is faced.

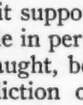
On Planning to Secure Economic Equilibrium

IT'S AN ILL WIND that blows nobody any good. The present state of economic and business affairs has its compensations. Many company executives, forced to initiate and effect drastic reforms, are willing to admit that a touch of adversity may be turned to good advantage; that a condition of economic disequilibrium spurs inventiveness and ingenuity. It stimulates thought, bringing the individual into closer contact with reality, forcing the disregard of camouflage.

One of the most depressing phases of a depression is the persistence with which certain propagandists endeavor to deflect attention from the obvious course being taken by events, in the hope that psychology may overthrow fact. One of the most hopeful signs of the present is that faith is no longer pinned on the efficacy of the injunction to the rank and file to "buy until it hurts," in an effort to restore the circulation of the body politic. Moderation in physical living standards and care in expenditures are no longer derided as un-American traits. The time is fast approaching when adequate attention will be paid to the fact that volume buying power is deserving of greater consideration than is the maintenance of a high wage scale among a decreasing number of wage earners; that no head of a family is entitled to encomiums because he has arranged that shelter, protection, and three square meals per day are still provided for only a majority of those for whose existence he is responsible.

Unemployment is due partly to the inequitable distribution of available work among the willing and capable. *Engineering and Mining Journal* long ago urged con-

sideration of the five-day working week and the ten-month working year. Recognizing the impermanence of the prosperity in evidence a few years back, it supported plans for assuring employment on a large scale in periods of trade depression. These plans came to naught, being submerged in a current of optimistic prediction of a never-ending era of freedom from poverty and of the indefinite maintenance of high standards of physical comfort, to be sustained by efficient production methods, and consumption to the limit of earning and borrowing capacity. Sponsors and disseminators of that philosophy are at least partly responsible for the plight of those who were led to take no heed for the morrow. The tendency has been too common in official quarters to expect the individual to solve those problems that are the direct result of an unthinking absorption of political propaganda.



Power Plants Provide Important Mercury Outlet

ABOUT 275,000 pounds of mercury, according to recent information obtained from the General Electric Company, will be used in each of two 20,000-kw. mercury-vapor units of the two power plants that are being erected at Schenectady, New York, and Kearny, New Jersey, respectively. Both plants, to be completed in the fall of 1932, will be operated by utility companies—the Schenectady plant by the New York Power & Light Company, and the Kearny plant by the Public Service Company of New Jersey. Each plant represents an investment of several million dollars.

These facts are encouraging in several respects. They are indicative of the practicability of the mercury-vapor boiler, pioneered by William LeRoy Emmet and the subject of much speculation, even as recently as a few years ago, when it frequently was described as being in the experimental stage. In the current period of economic disequilibrium, the additional employment that construction of the plants affords is an important contribution to the amelioration of existing conditions. With a much higher thermal efficiency and lower maintenance costs than plants producing power from coal, these two new units will probably be able to develop power at a comparatively low cost, and thus achieve another step forward in the struggle for ever cheaper power and the added opportunities that it should afford mankind.

To the mining industry, the success of the mercury-vapor boiler is particularly significant. For instance, six plants of the same size of those now under construction would provide an outlet for the annual mercury production of the United States, at the country's 1930 rate of output. Although the fact that sufficient mercury would not be available for a general replacement of power-producing units with mercury-vapor plants has already been pointed out, such action would probably not be advisable for several other reasons of equal economic importance. A gradual increase in the number of new plants of this type, however, may be expected; and, for the next few years at least, the mining industry may be counted on to supply the necessary amount of the liquid metal.

Road Building, Automobiles, and the Mining Industry

IN AN ADDRESS recently delivered in New York, M. Citroën, the French motor-car manufacturer, drew attention to the influence of the automobile industry on present economic life. The value of the last seven years' output of cars, about 20,000 million dollars, far exceeding the total gold supply of the world, is equal to one-third of the total national wealth of France, he stated. Such facts readily show how a serious curtailment in this field has far-reaching effects on all allied industries. M. Citroën, looking into the future, took a decidedly optimistic view, predicting a substantial increase in output. Of especial interest, however, was the emphasis he placed on a coordination in production and distribution policies among the chief producing nations, with removal of artificial trade barriers, avoidance of destructive competition, foundation of extensive credit systems, intelligent disposal of old cars, and extensive aid in the establishment of service facilities and building of roads in countries where markets were being developed.

Although judgment regarding the soundness of the proposed plan is beyond the scope of this publication, the mining engineer cannot fail to view with satisfaction a sign of recovery of an industry providing so important an outlet for metallic as well as non-metallic mineral products. The ambitious determination to go beyond the point of direct service to the customer, by establishing conditions that permit him to derive maximum usefulness and satisfaction from the article purchased, carries a modern trend in distribution to its final consequence. An example is furnished, worth studying by all who are confronted with the problem of distribution. A determined effort to promote road building as a means of extending the field of the motor car has also a direct bearing on the prosperity of numerous mining enterprises, especially in the non-metallic field. Such efforts deserve the whole-hearted cooperation of the entire industry.

The Surface Factor in Grinding Media

A PIECE OF ORE on the die of a stamp battery has no means of escape when the shoe falls upon it. If the die and the shoe were spherical, however, one can imagine that the piece of ore would probably escape entire or incomplete fracture because of slippage, even if the height of discharge were maintained to insure an initial positioning of ore on die. That is what doubtless happens in a cylindrical mill with spherical grinding media. Does not, therefore, the question of the roughness or the smoothness of the surface of the media affect the output of ground ore and the efficiency of the unit in terms of power consumed?

Ore reduction in a cylindrical mill is effected by abrasion or rubbing, as well as by impact. Early work in pebble mills demonstrated that an economy in the cost of grinding media was the major result secured by the substitution of siliceous mine or quarry rock, jasper or flint, in place of natural pebbles. In many instances, a smaller amount of grinding was effected, generally because of

the fracturing of the substitute media and the additional work required for the reduction of the chips and coarse gravel produced. This outcome deflected attention to the primary requirements of such media—toughness and high specific gravity, rather than a hardness that usually connotes brittleness. And toughness is a characteristic of rocks with a rough surface, a surface that gives the ore particles a better grip; with the result that, in one large operation at least, a considerably higher duty was obtained by the use of spheres of tough rock, compared with the duty secured by the use of hard natural flints. Pebble consumption was higher, of course, but grinding cost per ton of product was much lower.

A grinding unit that reduces solely by abrasion, such as the grinding pan, operates at low efficiency if steel shoes and dies are used. A tough, rough-surfaced iron is preferable. Roller mills that grind by pressure give high efficiencies with steel wearing surfaces. The positive pinching action occurring between rolls with a correct angle of nip insures a high output regardless of the smoothness of the crushing surfaces; although a corrugated roll will naturally handle a feed of larger particle size.

Consideration of the foregoing facts and experiences suggests that the degree of grip of grinding surface on ore particles in a cylindrical mill may have a greater influence on output than is generally realized. In seeking grinding media possessing the ultimum in hardness, has a factor that influences reduction efficiency—the roughness of the grinding surfaces—been given adequate attention?

The Advantages of Stable Prices

WITH the prices of almost everything far below normal levels, of interest is the fact that quotations for three important products in the mining field have been maintained without concession. Aluminum was reduced by one cent a pound a little over a year ago; but, previous to that, no change had occurred since 1927. Nickel has sold on a basis price of 35 cents a pound since 1925, and sulphur has been $18 a long ton since 1926. Among products of somewhat less extensive use are the compounds of molybdenum, which has held on the 85-cent basis throughout the current year. All of these commodities are closely controlled by one or two companies, either as to United States or world supplies. The producers have evidently taken a long-range survey of the situation and fixed their prices at a figure that they estimate will result in the maximum profit. Were prices higher, a drop in consumption or a stimulation of other production would be unfavorable; were prices lower, the margin of profit would decline more than could be offset by increased consumption or the elimination of competition.

Producers evidently prefer stable prices in good years or bad, rather than excessively high prices in boom times, as copper enjoyed in 1929, and profitless operation in hard times, with copper again the outstanding example. Consumers also are satisfied. Though no statistics are available on the present consumption of nickel, aluminum, and sulphur, one may doubt if the use of these commodities has declined any more than that of copper, lead, or zinc. In fact, perhaps they have declined not so much, for consumers have not been waiting for the bottom to be reached, knowing pretty well that there will not be any bottom, or top either.

Automatic Processing of Non-Metallics

SCOPE in the use of non-metallic minerals for novel applications is illustrated by the fact that about 20,000 tons of diatomite was incorporated with asphaltum in 1930 in the manufacture of battery containers. This figure is given by Mr. V. L. Eardley-Wilmot in the latest issue of *Mineral Industry*, recently published. A large number of other applications are being found for this interesting material, the technique of mining and preparation of which has reached a high degree of efficiency. Mining practice at the Johns-Manville deposit at Lompoc, California, indicates the general abandonment of open-pit work, in favor of underground mining. The room-and-pillar method of extracting the material from the beds, which dip about 30 degrees, is used. Mechanical scraping and car haulage by electric locomotives offer indications of adoption of modern underground methods.

Diversification in application of the product has called for refinements in processing, and for the development of an adequate and efficient flowsheet for intermediate and super-fine grinding. The old bee-hive kilns have been replaced by modern continuous-tunnel kilns, with a capacity of 25,000 sawed brick per day. As a result of these developments, the character of the various products has reached a high degree of uniformity.

Despite the automaticity secured, the saving in fuel, the positiveness of control, and the reduction in labor requirements, operators in the non-metallic industries have been slow to scrap the familiar bee-hive furnace. Comparative data are scarce; but, on examination, the efficiency of the tunnel kiln for drying and pre-heating, for oxidation, burning, and cooling of crude and prepared non-metallic shapes, is as obvious as is the efficiency of an automatic sintering machine for the treatment of a metallic ore. Incidentally, the design and operation of the sintering machine now in common use has been so standardized and simplified that it has been applied with success for the production of brick from clinker usually discharged as waste from a coal-fired boiler, the sintering temperature being adjusted so that a degree of fusion of the component particles is secured sufficient to achieve unity and strength of the resultant brick, without sacrifice of lightness.

Equipment of sound design and economical operation may sometimes be applied for many uses beyond that for which it was primarily intended. This is particularly true in regard to the adaptation in the non-metallic industries of apparatus that has proved its worth in other fields.

Mining Copper in Baja California

Prepared by the technical staff of Compagnie Du Boleo under the direction of

M. Bellanger

Director General
Compagnie Du Boleo,
Paris, France

THE history of mining and exploiting copper in Baja California dates back to 1868. Large-scale operations were started by the Compagnie Du Boleo in 1886, and have been continuous since then, despite revolutionary disturbances. Operations cover an area of more than 618,000 hectares, and include mining, smelting, and shipping. Lack of railroad communication with the Mexican mainland and the United States, and inability to cultivate the surrounding desert country, forced the company to build a modern harbor at Santa Rosalia, about 260 miles north of La Paz, and to operate its own ships, to assure a steady supply of food and materials. Building of the harbor required two years. It contains a sheltered area of 44 acres, for ships with a draft not exceeding 25 ft. Thousands of 10-ton blocks, cast from smelter slag, were used in the construction of two piers one mile long and 60 ft. wide. An elaborate track system, cranes, and 10-in. pipe lines facilitate the loading and unloading of blister copper, various supplies, and fuel oil. A 300-hp. dredge is available for harbor maintenance.

Boleo's fleet consists of the S.S. "Argyll," a tanker of 9,000 tons and 300 ft. long, with a capacity of 28,000 bbl. of fuel oil, sailing under the French flag; the S.S. "Providencia," likewise under the French flag, of 2,950 tons and 225 ft. in length, for carrying timber, blister copper, and supplies; and the S.S. "Korrigan III," operating under the Mexican flag, with a gross tonnage of 960 tons and 170 ft. long, for freight and passenger service. Imported tonnage in 1930 amounted to 96,000 tons, classified as follows: Fuel oil, 60,000 tons; lumber, 20,000 tons; various goods, 10,000 tons; refractories, 1,500 tons; and miscellaneous, 5,000 tons. Blister copper exported totaled 12,000 tons.

The four principal mines—the Rancheria, Providencia, Purgatorio, and Santa Marta—are from one to four miles from the smelter and harbor at Santa Rosalia. Transportation equipment used between the mines and smelter consists of 20 miles of 3-ft. track, eight oil-fired Baldwin locomotives, and 6-ton railroad-type cars. Yearly tonnage hauled exceeds 400,000 tons of ore and supplies. San Luciano, a new mining center south of Santa Rosalia, now in course of development and construction, will be connected by a wire-rope tramway four miles long. The railroad department is also in charge of the shipment of blister copper, as well as the transportation of goods and supplies from the harbor to the warehouses.

In the Boleo district the basement rocks exposed are a series of andesite lava flows, locally called "trachyte." Overlying an uneven, eroded surface of the trachyte is a series of bedded tuffs and conglomerates deposited as an alluvial fan. The strike of these sediments is northwest, and the dip averages about 15 per cent (between 8 and 9 deg.) to the northeast. A cross-section of the series shows a coarse conglomerate, made up of lava pebbles at the base, overlain by tuffs containing angular fragments of lava. The whole series is thickest at the western edge, and tends to diminish in thickness to the east, toward the coast, where the tuff beds are often replaced by beds of gypsum. Near the coast, faulting has in places exposed the igneous basement rocks. The vertical succession near the western edge of the series shows alternating conglomerates and tuffs, with progressively less conglomerates as the distance increases from the basement rocks. Above the series of tuffs and conglomerates, and separated from them by an unconformity, is a series of calcareous and fossiliferous tuffs of Tertiary age.

The ore occurs in four major beds of clayey material in the lower series. These beds are found on the contact of tuff and conglomerate, or between two tuffs of different permeability. Starting from the top, bed No. 0 is usually absent, as a result of erosion. Bed No. 1 is at the contact of two tuffs of different permeability, but contains ore only at the southern end. The metal content of bed No. 2 is too low to make the bed of commercial value. Bed No. 3 is the principal bed mined. At the base of the series is a fifth bed, bed No. 4, resting directly on the trachyte floor. This bed is thicker than the others, but contains too little metal to be rated as ore. The thickness of the parts of beds Nos. 1 and 3 with a metal content is 2 m., of which 60 cm. is pay ore. Bed No. 4 is 10 m. thick. The ore beds are separated from each other by about 70 m. of barren rock.

A large number of normal faults occur, striking northwest, parallel with the coast line and with the strike of the formations. These faults are older than the ores, evidence being present that the metal-bearing solutions came through small fissures caused by faulting and subsidence. Also, the solutions apparently traveled through some of the faults themselves. Association of the ore with the faults indicates that its formation was subsequent to that of the beds. The chief ore mineral is finely disseminated chalcocite, which occurs in clayey tuffs. Whether the chalcocite is of primary origin or the product of the secondary enrichment of other primary sulphides has not been determined.

Beds Nos. 1 and 3, below the hydrostatic level, are the chief source of ore supply. The footwall of bed No. 1 consists of a gray sandy tuff, similar to soft sandstone, whereas the footwall of bed No. 3 is a cemented conglomerate. The hanging walls are a soft, red clayey tuff. To realize fully the difficulties encountered in drifting and stoping, one must bear in mind that the beds consist of soft, wet clay, resting either on a hard conglomerate or soft sandstone, and below a soft clayey formation. Static pressure, therefore, is abnormally great. Accordingly, drifts in the beds tend to close quickly, despite heavy timbering. Conditions, of course, are different when the beds are mined above the hydrostatic level. Decreased pressure of the overburden, and dry beds of greater consistency, in comparison to the conditions encountered on the lower levels, are found in the upper levels. Similar conditions are probably not found elsewhere in the world.

In exploration work on the surface, combination churn and core drills are used. At present the southern part of the district is being prospected for extension of the beds. Although beds Nos. 0, 1, and 2 have been found, no metal-bearing zone, other than that of

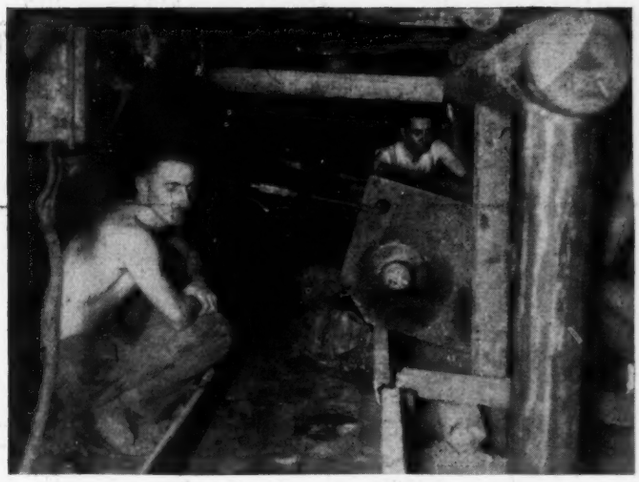
This is the first of two articles by the technical staff of Compagnie Du Boleo on the operations of the company at Santa Rosalia, Baja California, Mexico. The smelting of Boleo ores will be described in the second article, which will appear in an early issue.

bed No. 1, has been discovered in the area to date. This zone is about 200 m. wide along the dip of the bed. Prospect holes are drilled about 200 m. apart. In metal-bearing ground this distance is reduced to 100 m., to determine better the limits of such ground. Drilling is difficult, averaging 4 to 5 ft. per eight-hour shift in loose conglomerate; from 10 to 15 ft. in tuff; and, according to variations in hardness, from 5 to 15 ft. in gypsum.

In exploration and development work, samples are taken from the working faces by a sampler, the assay value of each sample subsequently being recorded on an assay map. The value of ore reserves determined thusly is about 25 per cent higher than the ore as mined. This great difference is caused by the ore being mixed with waste, inasmuch as fine waste cannot be separated efficiently from the ore in the stopes by hand sorting. If one person does all the sampling in any one section, the calculated value of the ore in the section is remarkably close to the value of the ore as mined, after this allowance of 25 per cent is made. Ore reserves are estimated annually by dividing the ground into blocks bounded by drifts and winzes, the cubic contents of the blocks being calculated from the length of the drifts and winzes and the average thickness of the ore. Stopes are measured every month and the mined-out areas computed. Ore from each mine is weighed at the smelter storage bins, to afford a yearly comparison between the calculated and actually stoped tonnage of ore.

Exploration drifts are advanced in the beds on a grade of 1 per cent. If payable ore is encountered, inclines are driven 200 m. apart along the strike of the vein. The length of these inclines average 150 m. along the dip. Next, drifts are driven from the bottom of the inclines, to block out the ore. The average vertical distance between the two levels is 20 m. Dimensions of the drifts inside the timber are: height, 1.80 m.; width at cap, 1.30 m.; and width at floor, 2.30 m. This size of drift affords ample room for the 20-in. track and the 1,000-lb. cars. Explosives are seldom required in driving level drifts. At the working face, high temperatures prevail and timbering is necessary. A phenomenon observed some distance from the face is a lateral movement of the drift walls, combined with a swelling of the floor where the footwall consists of other than conglomerate, and subsidence of the roof, which is particularly pronounced in the metal-bearing areas. Frequently, cars cannot reach the face a few days after the erection of new timber. This will explain why the drifts do not exceed 60 to 70 m. in length, and must be abandoned after sampling. Also, why small and light mine cars are employed.

Ventilation at the face is provided by small, portable 8.5-hp. electric fans of 2,000 cu.ft. capacity, equipped with 200 ft. of 16-in. canvas pipe. Timber salvaged is negligible. Advance made in the level drifts is about 35 m. a month, on a two-shift basis. Operating conditions are more trying in the inclines. Water at 120 deg. F. and slow oxidation of sulphides have a detrimental effect upon men and operations. The average advance in normal ground is 25 m. a month. In bad ground this is reduced to 15 or even 10 m.



Junction of two underground belt conveyors

Each incline is equipped with a home-made 7.5-hp. single-drum portable hoist; a portable centrifugal pump of 15 cu.m. an hour capacity, driven by an 8.5-hp. motor; and a centrifugal fan of the type employed in the level drifts. After sufficient tonnage has been blocked out by this method, haulage levels and incline shafts are driven in the footwall, about 6 m. below the bed. This avoids subsidence of the roof and swelling of the floor.

Although the conglomerate below bed No. 3 is not thoroughly cemented, timbering is seldom necessary. Drifts in the tuff below bed No. 1, on the contrary, always require timbering. For drifting in conglomerate, I-R DCRW 23 mounted Jackhamers and 40 per cent gelatine dynamite are used exclusively. The average advance is 5 ft. a round, and the complete cycle—that is, drilling and blasting the ten-hole round and mucking—requires about nine hours. All mucking is performed manually. The cost for drilling, blasting, and mucking is 15 pesos, and for explosives 7.40 pesos, a meter. In tuff, the holes are drilled by hand in about one and one-half hours. The remainder of the shift is spent timbering and mucking. Haulage drifts measure 2x2.60 m. in cross-section, and provide ample space for two 20-in. tracks and a drain ditch.

The ore deposits are mined by a short-wall method. The 200-m. stoping area between the inclines, or winzes, is subdivided into small stopes by sublevels and crosscuts. Broken ore from the working face of each stope is transported to the loading chutes, either on electric-driven conveyors or in small ½-ton cars. The 150-m. incline, or face of the bed to be stoped, is divided into sections of 30 m., when the conveyor method is used, and into 20-m. sections when car transport is employed. Stoping operations commence at the upper end of the incline. The length of advance is determined by the condition of the ground, and, with the conveyor method, rarely exceeds 60 m. Each stope is abandoned and a new one started below after this depth is reached. To advance deeper into the bed is found impracticable, because subsidence and upkeep of sublevels would adversely affect stoping costs. In fact, the pressure in these levels is so great that timber must be replaced twice before the 60-m. advance is completed. Consequently, with the slower car-transport method, the stope advance is reduced to 50 m.

When the mined-out area along the entire length of an incline has reached a uniform depth of 60 m., stoping operations are discontinued, and started in the incline 200 m. distant, with an advance toward the abandoned workings. The average advance, on a two-shift basis, with the conveyor and car methods is 25 and 20 m. a month, respectively. As subsidence is greater ahead than behind the working face, only advance methods can be used at the Boleo mines. In bad ground, to keep a drift open ahead of the face is practically impossible. The change of equilibrium is felt as far as 100 m. ahead of the advancing face.

Although but 2 ft. of the bed is pay ore, a height of 6 ft. is mined. Waste is thrown back of the conveyors or cars, and serves as filling for the mined-out area. Surplus waste is hoisted to the surface. The extra cost of mining a 6-ft. face is counterbalanced by the savings derived from improved operating conditions at the face. Experiments were conducted some years ago to mine the ore along the dip of the bed, but falling rock from the face and difficul-

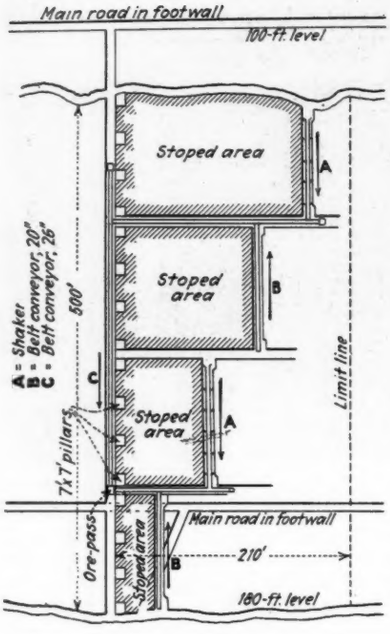


Fig. 1—Plan of stoping operations, showing shakers and belt conveyors

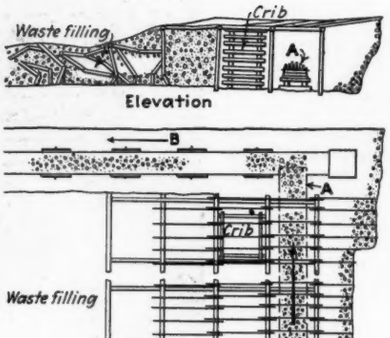


Fig. 2—Detailed sketch of stoping method

ties in timbering compelled the discontinuance of this method. Longwall mining, with 90-m. faces, also proved to be a failure, because of abnormal ground subsidence.

Stope timbering in normal ground consists of a series of props spaced at 1.30 m. in straight rows 1.20 m. apart. The last row is placed 1.20 m. from the working face. Whenever necessary, temporary props are set 60 cm. ahead of the last row of props. Generally, sufficient waste is obtained from the face for filling purposes. Heavy ground is supported by cribs made from 4x4-in. pine timber. To protect the men from falling rocks, lagging is carried close to the face. The ore, being soft and friable, is broken with standard handpicks and shoveled manually onto the conveyor or into cars. No mechanical loading devices have been applied, up to this time, because of the limited space available along the face. The layout of a stope in exploitation and the details of the stoping method employed are shown in Figs. 1 and 2.

All stoping is done on contract, a 2.20 m. face being allotted to each contractor. When employing the car method of ore transport, the crew at each face consists of the contractor and a helper. The price per loaded car is determined by the thickness of the ore at the face. Breaking of ore and timbering are done by the contractor, the helper being responsible for an adequate supply of cars, loading, and the transportation of loaded cars from the face to the loading station. Loaded cars are controlled by means of sprags attached to the wheels, if the grade of the stope does not exceed 15 deg., and by specially designed brake pulleys if the grade is more. The time record of an average miner per eight-hour shift is about as follows: Mining, two hours 40 minutes; timbering, three hours 11 minutes; or a total of five hours 51 minutes. The helper spends one hour in timbering and four hours 20 minutes in loading and hauling cars, or a total of five hours 20 minutes. A miner is paid 4.50 pesos per shift, and a helper 3 pesos. Disadvantages of transporting the ore in cars include: (1) a large number of cars are required, involving high maintenance and haulage costs; (2) an extensive track system is necessary; (3) accident rate is increased; (4) maintenance of the numerous sublevels is costly, because the rate of advance is slow.

Owing to the aforesaid disadvantages, the plan of ore transport that has been adopted as a standard at Boleo is the conveyor method. Ore broken at the face is thrown onto an electric-driven 20-in. conveyor, and, when moved upgrade, then falls onto a second 20-in. conveyor in the sublevel, and next onto a 26-in. conveyor in the incline that discharges into a loading chute, as shown in Fig. 1. When moved downgrade, the broken ore is thrown onto an electric shaker, which delivers it to the sublevel conveyor. From the loading chute the ore is discharged into cars for transport out of the mine. The average width of face allotted to each miner is the same as that used with the car method—namely, 2.20 m. No helper is necessary. Three hours are required for mining and shoveling, and 1½ hours for timbering, or a total of 4½ hours. A miner receives 5.95 pesos per shift. Advance per shift is 1.1 m. Fewer sublevels are employed with the conveyor method, because the stope faces are longer and a closer control of stopes is possible.

Conveyors and shakers used are of the Meco type, made by The Mining Engineering Company, Worcester, England. Each shaker consists of a series of 9-ft. sections, coupled together by eyelets and bolts. The driving mechanism and the small motor can be placed either under one of the troughs or at the elevated end of the shaker. Which of the two methods is the better has not as yet been determined. The usual practice at Boleo is to connect the driving mechanism, resting under the trough, by a reinforced 6-ft. rod. This permits a more compact erection of the shaker, with additional space between the top of the shaker and the roof. The troughs, depending on the condition of the ground, rest either on rollers on the floor or are suspended from the roof by adjustable chains. Three men can easily move a 30-m. shaker in less than two hours.

The 20- and 26-in. conveyors are also built in short sections, and have an over-all height of 18 in. They are driven by 5-, 8-, or 10-hp. fully inclosed motors. The drive mechanism consists of two driving and one idler pulley. Motive power is transmitted by worm and helical gears. Ball bearings are used exclusively. The return or tension pulley, controlled by chains and a jack of the Sylvester type, is 30 in. in diameter. The driving and idler rollers measure 4 and 2½ in., respectively, and are mounted on the frames, with 6-ft. centers. Home-made spring centralizers govern the load on the 26-in. conveyors, and spill-proof side angles, attached to the roller frames, prevent spillage of ore. The return belt is protected by spill-proof plates. The four-ply 20-in. belts and the five-ply 26-in. belts are made of a rubber-impregnated cotton fabric, with rubber-coated faces, and contain special fasteners, of the Alligator type, to facilitate adjustment of the belts. Maintenance cost is 0.15 pesos per ton of ore mined. The conveyors are silent in operation, thus making any ground movements readily heard.

The percentage of output carried by the conveyors was 38 per cent in 1927; 60, in 1928; 65, in 1929; 77, in 1930; 86, in February, 1931; and 90 per cent, in March, 1931. In 1930 the man out-

At the face in a Boleo stope

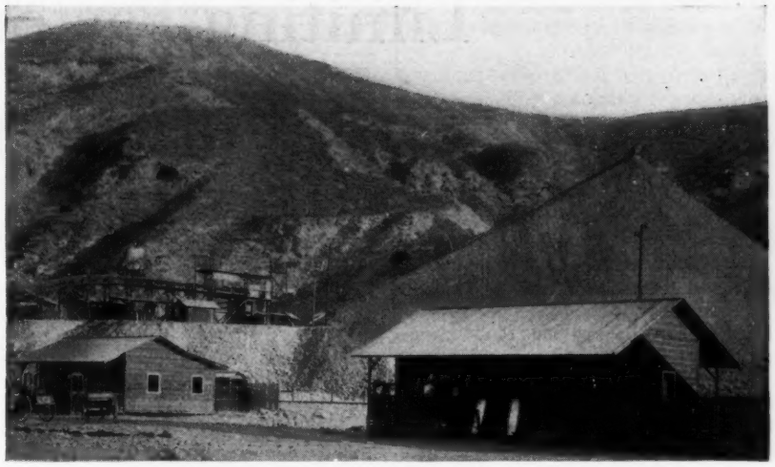
put per shift was 1,364 kg. with the car method and 2,126 kg. with conveyors. The cost for stoping one square meter was 6.81 pesos, in comparison to 3.59 pesos under the car method.

After the strike in 1925, increased wages, high timber costs, and other derogatory factors caused the company great concern. To reduce operating losses to a minimum, exploration and development work were suspended and numerous underground workings abandoned. Means had to be found to reduce over-all costs to conform with current economic conditions. Experiments conducted underground with electric conveyors in 1927 were so encouraging that a decision was made to apply them on a large scale. Results obtained were particularly gratifying. Output per man per shift increased from 1,352 kg. in 1927 to 1,916 kg. in 1930, and to 2,126 kg. in March, 1931. Increased profits that resulted led to the purchase of the following equipment: 46 additional conveyors; 24 electric 8.5-hp. portable blowers, for development work; 30 pumps; 1 portable compressor; 15 miles of electric cable; 6 electric double-drum hoists and 10 single-drum hoists.

Development and exploration work was increased from 4.7 per cent in 1927 to 9.6 per cent in 1930; the number of men in the stopes decreased from 46 to 34.4 per cent; and opening up of caved and abandoned workings raised the upkeep costs from 18.7 to 23.4 per cent. Total advance in stopes and drifts increased from 5.527 to 9.327 m., despite the fact that in 1930 most of the ore mined came from below the hydrostatic level.

Primary ventilation for the four mines is supplied by eight multi-blade fans, 1.75 m. in diameter, driven by 90- and 125-hp. induction motors and 500-hp. synchronous motors. Portable 8.5-hp. fans and 16-in. canvas tubing furnish air to stopes, drifts, and winzes. Mules are used underground for hauling trains of ten cars, of 400 kg. capacity each, from the loading chutes to the shaft stations. Ore and waste are hoisted in trains of six and ten cars, at an average speed of 2 to 3 m. a second, through incline shafts from 100 to 350 m. in length, with grades varying from 20 to 30 per cent. On the surface the ore is discharged upon slow-moving 3-ft. apron conveyors, where it is hand-sorted. Waste is disposed of automatically at waste dumps, equipped with an incline track and cable-operated bottom-dump cars. The selected ore is dumped by apron conveyors into large loading bins, whence it is transported in 6-ton railroad cars to the smelter storage plant.

The mines are in charge of a superintendent, aided by an assistant and a safety engineer. The operating personnel of each mine consists of a graduate mining engineer, an accountant, and a foreman. Shift bosses are chosen from the native workers. A mechanical and electrical engineer and a crew of repair men are responsible for the upkeep and safety of machinery underground and on the surface. Well-equipped shops are maintained at each mine.



Automatic waste disposal plant at the Rancheria mine

Operating costs and production statistics for 1930 are presented in the accompanying table. Basic wages in 1930 averaged $4.14 (Mexican pesos) for employees on contract work, and $3.16 for other employees, the average wage being $3.538. To these figures, however, must be added $0.376 for different premiums and a bonus based on the price of copper. For the first four months of 1930 the total average wage was $4.65 (Mexican pesos).

Prior to the creation of a safety department in 1927, the accident rate at the mines of the company was high. To improve conditions required a rigorous safety campaign. Confronted with negligence, and lack of discipline and interest on the part of labor, the preliminary work was difficult and required sound planning, leadership, and patience. Application of mechanical safety devices, constant vigilance to correct unsafe conditions underground, the installation of conveyors, and cooperation between labor and the safety department are responsible for the excellent results that have been achieved. The accident rate per 1,000 man-shifts (eight hours) decreased from 6.28 per cent in 1927 to 3.75 in 1928, 2.44 in 1929, 2.22 in 1930, and to 0.68 per cent in March, 1931. No fatal accident had occurred in the seventeen months ended March 31, 1931, representing a total of 1,150,000 man-shifts.

The safety department is in charge of a Mexican engineer, or *Ingeniero responsable*. His duties include periodical inspections of mines and plants, and statistical work. Copies of reports covering inspection trips and observations are sent to the chief engineer and the superintendent in charge of each mine, and one copy is kept on file. Monthly reports sent to every department head and operating personnel include details as to the number and nature of lost-time accidents, their classification, and the amount of bonus paid to foremen and shift bosses. The maximum bonus paid to foremen and shift bosses for no lost-time accidents is 60 and 30 pesos a month, respectively. Minor accidents reduce the premium, and it is omitted when serious or fatal accidents occur, or when evidence of negligent supervision is found.

Public safety contests are held periodically, in which teams from the four mines and the smelter participate. Each team is composed of eight men, equipped with Legendre & Nicloux inhalation masks and Panis artificial respiration apparatus. The company's mine rescue station is equipped with six Fenzy two-hour machines, and a monthly practice of the mine rescue team is compulsory.

Operating Costs and Production Statistics for 1930

	Production by Car-Transport Method	Production by Conveyor Method	Total
Output, metric tons	70,375	235,100	305,475
Man-shifts	51,606	110,586	162,192
Output per man-shift, kg.	1,364	2,126	1,883

Average cost of mining 305,475 metric tons, in Mexican pesos: labor, $1.93; miscellaneous, $1.54; total, $3.47.

Average cost of development per lineal meter, in Mexican pesos: labor, $20.68; timber and miscellaneous, $952; total, $30.20.

Total Costs per Metric Ton of Ore

In Mexican pesos

Labor	$5.503
Timber, steel	2.453
Miscellaneous	0.279
Engineers, foremen	0.273
Mine cars	0.134
Repair shop	0.133
Installations	0.023
Electricity	0.291
Laboratory	0.022
Railroad	0.029
Conveyors	0.108
Equipages	0.218
Total	$9.466

Consumption of timber per ton of ore: props, 6.75 lineal feet; 4x4-in. material, 6.79 lineal feet; total, 13.54 lineal feet. Total cost of timber $673,805.55 (Mexican pesos).

Limiting Factors in QUICKSILVER METALLURGY

C. N. Schuette

PROGRESS in metallurgic art is ever widening the limits within which metals can be beneficiated at economic profit. This advance proceeds toward various objectives, such as treatment of more complex ores and treatment of lover-grade ores. The impetus to progress may be a national need for, or monopoly of, production; competition between producers or consumers and increased demand created by newly discovered uses or decreased demand resulting from the use of substitutes. Generally, the practical effect of these stimuli is expressed in higher or lower prices for the metal. Every expansion of existing metallurgic limits results in an increased potential supply of the metal affected.

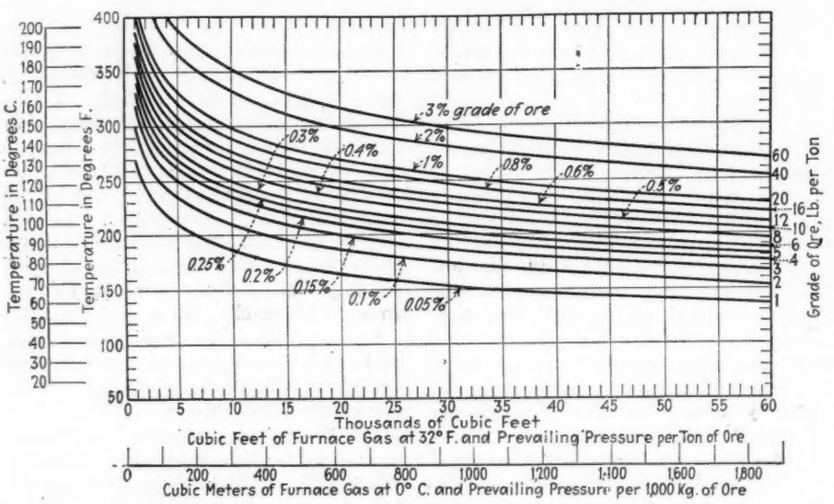


Fig. 1—Relation between ore grade, temperature, and volume of furnace gas per ton of ore

Progress in the metallurgy of quicksilver has been directed principally toward reducing the limit imposed by the lowest grade of ore that could be treated at a profit. A few quicksilver mines present individual problems owing to the presence of large quantities of pyrite, sulphur, antimony, or arsenic in the ore, but such complex ore is usual and its treatment does not impose a major limit to production.

The principal progress for many years has been in the development of furnaces for the treatment of finely divided low-grade ore. When the grade of ore treated in these furnaces drops below 10 lb. of quicksilver per ton, or one-half of 1 per cent, the function of the condenser system in recovering the quicksilver from the furnace gases becomes of increasing importance. This fact has not yet been generally recognized, and the lack of recognition of it is responsible for an appreciable but avoidable loss of product at many plants.

Aside from sorting, which is standard practice at most quicksilver mines, few metallurgical processes are used in reducing quicksilver ore. Sorting usually begins in the mine as selective mining. Thereafter more or less hand sorting and screening, depending on the characteristics of the ore, is practiced until the ore is delivered into the treatment-plant bin.

Table concentration, flotation, and leaching are all possible methods of beneficiation, and are sometimes used, but generally prove less economical than direct furnace reduction. The most promising avenue of progress in quicksilver metallurgy is still confined to the improvement of direct furnace treatment, rather than to the development of concentration or leaching processes. In the furnace treatment of ever lower-grade ores the physical and chemical principles underlying the process of recovery are of fundamental importance. A clear understanding of just what happens and how it happens is necessary to design the most effective apparatus for recovery.

During the last ten years the low-grade limit in direct furnace treatment has been extended from 5 lb. (0.25 per cent) to 3 lb. (0.15 per cent). A similar progression in the next ten years would result in the economic treatment of 1-lb. (0.05 per cent) ore. The present status of this limit can be illustrated by the following example: Suppose an old quicksilver mine had available a half million tons of dump material that would run not less than one pound of quicksilver per ton. A reduction plant capable of treating 100 tons per day can be built for $50,000. The operating costs are as follows:

	Per Ton
Mining by shovel	$0.30
Transportation to plant	0.10
Crushing	0.05
Plant amortization	0.10
Plant labor	0.20
Fuel	0.35
Power and maintenance	0.05
Overhead	0.05
Total	$1.20

Assuming a 90 per cent recovery, this operation would pay when the price of quicksilver is $100 per flask or better. Under favorable conditions the costs as outlined are possible. Annual production from this operation would be 432 flasks at a cost of $100 per flask. Using the *E.&M.J.* average prices for the last four years as a basis, a modest profit could have been made as follows:

Year	1927	1928	1929	1930
Average price per flask	$118.16	$123.51	$122.15	$115.00
Assumed average selling price	115	120	119	113
Profit per year	$6,480	$8,640	$8,208	$5,616

Such profit might not tempt one to go into the business, but when it is remembered that this profit is postulated on the treatment of only one-pound ore, the one-pound limit does not seem impossible of achievement. Certainly in times of national emergency material of this kind would constitute a reserve. The total reduction cost of only 70c. per ton (a 50c. cost is not improbable) shows why direct furnace treatment is generally cheaper than any form of concentration or leaching, which involves fine grinding as an item of cost.

A 90 per cent recovery has been assumed in the foregoing example. The justification for this assumption is contained in the following discussion. A quicksilver reduction plant properly designed and operated has practically no losses except the stack loss. The magnitude of this loss in good, bad, and indifferently built plants is given in the accompanying table, which lists the pertinent data of nine plants at which I determined stack losses. Column 4 of the table lists the stack loss determined by sampling, whereas Column 5 lists the non-recoverable loss under the conditions of operation. This latter loss

is the quicksilver which remains in the gas as an uncondensed vapor at the temperature of the escaping gas.

Four of the nine plants listed had such large stack losses that new condensers were designed to correct this defect. The others show that serious stack loss can be avoided, but at many plants no one worries about losses of any kind as long as the operation pays.

With lower-grade ore the danger of stack loss increases owing to the lower dew point or temperature at which the quicksilver will condense. The dew point varies between wide limits for various grades of ore and for different gas volumes. No quicksilver can condense or be caught in the condenser system until the gas temperature has dropped to the saturation point. This dew-point temperature can be determined from Fig. 1, and for the nine plants under discussion is listed in Column 12 of the table. Column 14 of the table lists the dew point for the same conditions of operation if one-pound ore had been treated.

The practical effect of treating lower-grade ore in the nine condenser systems listed in the table is illustrated by Fig. 2. The area of the horizonal strips represents 100 per cent of the cooling area of the individual condenser systems. Gases enter at *e* and leave the stack at *s*; *h* shows the advance of the gases past the cooling area before the dew point, as fixed by the conditions of operation, is reached; *l* shows how much farther the gases would advance before condensation would occur if one-pound ore were being treated.

That less effective use of the cooling and collecting agencies of the condenser is made when treating one-pound ore is plainly evident. The difference in effective area is of course greatest for the largest difference in grades of ore treated. For system "A" and "C," which showed small losses when treating 25-lb. (1.25 per cent) ore, the gases would be halfway through the system before condensation could occur if one-pound ore had been treated, and a proportionately larger stack loss for the latter case is probable.

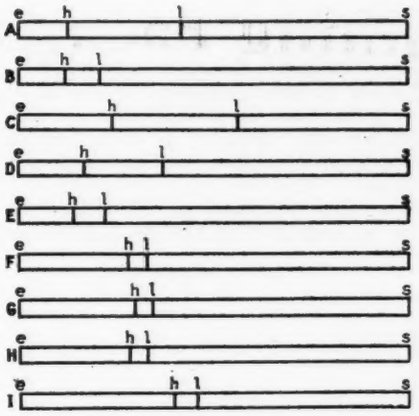


Fig. 2—Comparison of condenser effectiveness

Fig. 2 also shows that a lesser part of the condenser system is utilized for recovery in those systems showing the highest losses. Systems "B" and "E," treating 5-lb. (0.25 per cent) ore, however, would be nearly as effective as when treating one-pound ore. Assuming that the rate of total loss as against vapor loss remains the same (practically this would be true except for plants "A," "C," and perhaps "D"), the losses on a basis of one-pound ore would be those listed in Column 13 of the table.

Evidently the type of condenser system for which the total loss does not greatly exceed the non-recoverable vapor loss—for example, plants "B" and "E"—is quite capable of recovering better than 90 per cent of the quicksilver in the furnace gases as assumed in the forgoing example.

On the other hand, condensers not properly designed to meet the conditions of operation give rise to large stack losses, as, for example, plants "F," "G," and "H," which on one-pound ore would recover nothing. I have actually seen two plants built with such a complete lack of understanding of the principles involved that the dew point was in the stack and practically no recovery resulted from the operation.

From Fig. 1 it is evident that increased gas volume lowers the dew point. Inward leakage of air (which in one of the examples cited was as high at 127 per cent, see Column 9 of the table), as a contributing factor to large gas volume can be avoided almost entirely. The amount of water vapor (Column 10, Table I) cannot always be avoided, and another occasional contributing factor to large gas volume is the liberation of carbon dioxide from the calcium or magnesium carbonates in the ore.

The over-all cooling efficiency of condenser systems is best compared by the difference between the stack and atmospheric temperatures shown in Column 6 of the table. A good condenser system should cool the gases to within 25 deg. F. of atmospheric temperature.

The factors affecting the design of condenser plants for the treatment of low-grade ores are tonnage throughput of the furnace, grade and moisture content of the ore, the absence or presence of pyrite and carbonates in the ore, roasting characteristics of the ore, elevation of the plant, and the maximum and minimum temperatures at the plant site. Due consideration of the factors before a plant is built will often avoid expensive changes found necessary after operation has begun.

In operating plants, stack loss of serious proportions is indicated when sufficient quicksilver accumulates in the stack flue to make its recovery worth while by frequent clean-ups. With a suitably designed condenser plant, the amount of quicksilver recovered from the stack flue should not exceed ½ per cent of the total production. Gold leaf suspended in the stack gas is not a reliable indicator of stack loss, as it becomes coated with a film of water, and so may not amalgamate even when the loss is high. Stack loss, as a barrier to the achievement of new limits, can be combated effectively by correct condenser design.

A more dangerous possibility of loss exists at the top of the furnace. Scott and Herreshoff furnaces may be under pressure at the top, and hot, quicksilver-laden gases escaping at this point may be a source of serious loss. Adequate

Stack Loss at Quicksilver Reduction Plants

English System

(1)	(2)	(3)	(4)		(5)		(6)			(7)	(8)	(9)	(10)	(11)	(12)	(13)		(14)
Plant	Throughput per 24 Hours, Tons	Grade of Ore, Lb. per Ton	24-Hr. Stack Loss by Sampling		24-Hr. Non-Recoverable Stack Loss Under Conditions of Operation		Temperatures			Barometric Pressure, Inches Mercury	Measured Gas Volume per 24 Hours at Stack Conditions, Cubic Feet	Dilution of Gas by Inward Leakage of Air, Per Cent	Water Vapor in Gases, Per Cent	Gas Volume, Including Water Vapor, Measured at 32°F. and Prevailing Pressure, Cubic Feet per Ton	Dew Point, °F.	Stack Loss in Per Cent of Input If 1 Lb. Ore Had Been Treated Under Same Conditions of Operation		Dew Point for 1 Lb. Ore °F.
			Lb.	Per Cent of Input	Lb.	Per Cent of Input	Stack Gas, °F.	Atmosphere, °F.	Difference, °F.							Total Loss Per Cent	Non-Recoverable Vapor Loss, Per Cent	
A	60	25.0	5.13	0.342	4.62	0.308	103	81	22	27.2	2,460,000	127	28.0	42,500	248	8.56	7.7	144
B	90	5.0	7.17	1.590	5.48	1.22	89	75	14	29.6	2,210,000	0	11.0	23,300	213	7.97	6.1	161
C	70	25.0	18.00	1.030	6.12	0.35	100	57	43	27.2	3,435,000	116	27.0	51,200	240	25.7	8.75	140
D	51	10.3	17.31	3.300	11.70	2.20	129	88	41	27.1	1,440,000	57	33.8	26,700	234	34.0	23.0	156
E	40	5.0	1.59	0.795	0.37	0.185	53	45	8	28.0	850,000	0	10.2	22,200	217	3.98	0.925	162
F	130	5.71	164.30	22.2	22.11	2.98	107	52	55	26.89	5,170,000	21	18.5	37,400	200	126.5	17.0	147
G	61	5.75	79.40	22.6	8.91	2.54	93	49	44	26.95	4,890,000	62	19.5	80,000	178	130.0	14.6	131
H	124	6.02	195.00	26.2	19.89	2.66	109	53	56	26.65	5,280,000	57	19.0	39,400	200	157.0	16.0	146
I	34	5.5	16.58	8.82	8.45	4.49	106	62	44	27.95	1,700,000	5	11.2	44,300	193	48.5	24.7	143

draft, mechanically induced, is the remedy. Many rotary kilns are known to smoke at the connection between the kiln and dust chamber and also at the opening through which the feed pipe operates. An in-draft should prevail at these danger points, and the seal should serve merely to prevent inward leakage of cold air. A seal of this kind, which I have developed, is shown in Fig. 3.

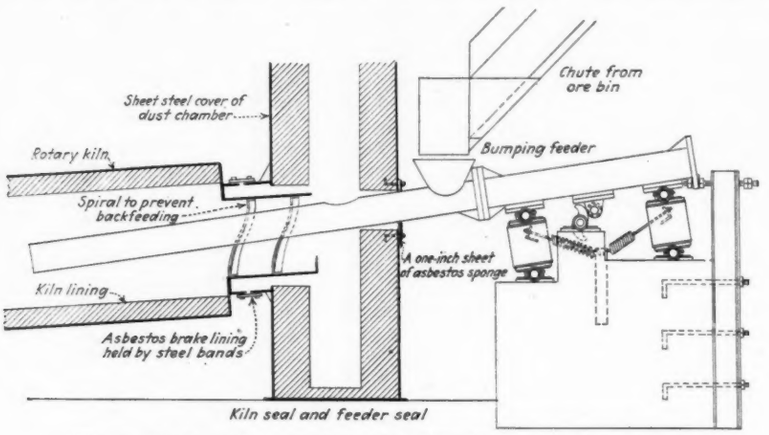

Chute from ore bin
Sheet steel cover of dust chamber
Bumping feeder
Rotary kiln
Spiral to prevent backfeeding
A one-inch sheet of asbestos sponge
Kiln lining
Asbestos brake lining held by steel bands
Kiln seal and feeder seal

Fig. 3—Seals used to prevent air infiltration on rotary furnaces

Such seals are easily made of either welded sheet steel or of cast iron. Since they are attached to the end of the kiln they increase the effective length of the kiln by several feet over older forms which I illustrated in U. S. Bureau of Mines Bulletin 335.

The inner tube with the spiral, of the seal shown in Fig. 3, prevents back feeding of ore into the dust chamber and dust from falling into the seal. The two outer rings are concentric about the axis of the kiln. One is attached to the sheet-steel cover of the dust chamber and is therefore stationary. The other one revolves with the kiln. The one-inch gap between them is covered by an asbestos brake band which is clamped tightly to the stationary ring and loosely around the revolving ring so that a tight sliding joint is formed. Graphite can be used as a lubricant. The feed pipe opening is sealed by clamping a sheet of asbestos sponge, which fits tightly around the pipe, to the wall of the dust chamber. With such seals to prevent inward leakage of air it is quite easy to maintain a slight suction in the dust chamber. An inward draft in the dust chamber guarantees the absence of loss at this point. Such loss can seriously limit both the recovery and output of a plant, as explained further on.

The ancient Scott furnace bugaboo, that the losses necessarily amounted to 30 to 40 per cent of the input, was effectively killed by investigations previously described,[1] but recently a new one has been developing in conjunction with rotary furnace practice. It is this: When a greater than normal tonnage of a given grade of ore is put through the furnace, less quicksilver is produced than even the normal throughput will yield. "Mysterious chemical reactions" or increased stack loss or other things are blamed for this phenomenon.

The condition appears to be: The kiln has been treating 50 tons per day of 5-lb. ore. Recovery is 95 per cent of input and monthly production is 93 flasks. The ore is well burned and operation is satisfactory. It is decided to increase the throughput to 60 tons per day and thus produce 112 flasks per month. At the end of the month "mysterious chemical reactions" or increased stack loss or other things are held to be responsible when the output is only 84 flasks, or less than was produced from a smaller tonnage in the previous month. It cannot be anything else, because "the ore was well burned and the condensers were thoroughly cleaned."

The rotary kiln in quicksilver practice, as in practically all operations where it is used, is run by the eye of the operator. He knows by sight when the ore is well burned, fires accordingly, and that is as it should be. The increased tonnage needed extra fuel and got it. Gas cannot be seen nor easily measured, but the gas volume per ton of ore is practically a constant for any one operation. Increased tonnage means a proportionately increased gas volume. The mechanical draft inducer operated from an engine or motor at constant speed. No one gave it a thought. At a fixed speed, temperature, and pressure, it moved so much gas and no more. Draft was provided by an exhauster which operated at the top of the dust chamber on hot gas. With greater throughput the increase of fuel burned increased the temperature of the gas in the fan from, say, 550 to 600 deg. F. This means that the exhauster moved about 6 per cent less gas at the higher-throughput temperature.

The gas volume at 50 tons throughput was 25,000 cu.ft. per ton measured at 32 deg. F. and 760-mm. pressure. Then, at 550 deg. and a 50-ton throughput, the exhauster moved

$$25{,}000 \times \frac{1{,}010}{492} = 51{,}400 \times 50 =$$

2,560,000 cu.ft. per 24 hr.

At 600 deg. it handled 6 per cent less, or 2,410,000 cu.ft., per 24 hr.

The total gas volume from the furnace however at 600 deg. was $25{,}000 \times \frac{1{,}060}{492}$ $= 53{,}800 \times 60 = 3{,}225{,}000$ cu.ft. per 24 hr.

Then 3,225,000 — 2,410,000 = 815,000 cu.ft. per 24 hr. must escape around the dust chamber openings, as the exhauster cannot handle them. This amounts to an escape of 25.3 per cent. of the quicksilver-laden gas volume.

The total gas volume per day contained 60x5 = 300 lb., of quicksilver. Of this 25.3 per cent, or 76 lb., escaped, and only 300 — 76 = 224 lb. reached the condenser. Of the latter amount 95 per cent., or 213 lb., is recovered. The output at the end of the month then is $\frac{213 \times 30}{76} = 84$ flasks.

Twenty-eight flasks have been lost, and the "other things" that caused it was insufficient draft. This example illustrates the possible magnitude of loss when furnace "smokes." Loss at this point is much more to be feared than stack loss. It generally advertises itself by the quicksilver content of dust settling on roof beams and trusses above the source of leakage. The amount of escaped quicksilver thus found is, however, a very small part of the total that is lost, since dilution of the escaping vapor with air must be so great that the dew point of the mixture becomes lower than atmospheric temperature and most of the quicksilver blows away as uncondensed vapor.

Many kilns could operate at greater throughput with a little intelligent attention to draft conditions. The extension of this throughput limit should be helpful in view of the recent recession in price. Proper draft, then, is very important in preventing losses and when increasing throughput. The various forms of dust-collecting cyclones, and particularly the Sirocco dust collector, recently described[2], must also be operated to conform to certain very definite draft limits. Although many plants have elaborate and expensive instruments for recording temperatures, there is a noticeable absence of even the simplest of draft gages. Such instruments are not expensive and should prove a useful aid to operation.

Losses, then, as limiting factors in the treatment of lower-grade ore, can be minimized by proper design and operation, giving particular attention to proper correlation between gas volume, dew point, condenser area, and draft.

[1]Duschak, L. H., and Schuette, C. N.: "Condensing Quicksilver From Furnace Gases." *M.&S.P.*, Vol. 117, 1918, p. 315.
Duschak, L. H., and Schuette, C. N.: "Fume and Other Losses in Condensing Quicksilver From Furnace Gases." Tech. p. 96, U. S. Bureau of Mines, 1919.
Duschak, L. H., and Schuette, C. N.: "The Metallurgy of Quicksilver." Bull. 222. U. S. Bureau of Mines, 1925.

[2]Schuette, C. N.: "Recent Design of Quicksilver Plants." *E.&M.J.*, Vol. 131, 1931, p. 316.

Copper Resources of Brazil

Luiz Flôrez de Moraes Rego

ALTHOUGH no extensive deposits of copper are known in Brazil, some have been found which, if properly developed, would probably fill domestic requirements of the metal. Genetically the copper deposits of Brazil may be divided into two main groups: (*a*) deposits occurring in Pre-Devonian igneous rocks; and (*b*) deposits occurring in Mesozoic basaltic rocks. The mineralization of the latter group, now recognized as containing deposits of no commercial value, consists mainly of native copper occurring in melaphyre, together with many minerals belonging to a paragenesis where zeolites predominate, with quartz, calcite, and others. Opinions regarding the origin of these minerals differ to some degree. It may possibly be connected with the phenomenon of zeolitization, from waters carrying copper, leached, perhaps, from rock in which some pyrites is disseminated, or from depth. Native copper is transformed into malachite by katamorphic alteration, as is proved by beautiful specimens consisting of metallic copper under a malachite surface. Some sulphides are also found with the native copper. Chalcocite, however, is rarely included in these. Such occurrences of copper are common in all outcrops in the Triassic series of San Bento, consisting in the main of basalt and melaphyres, in a wide zone in Southern Brazil; also at Serra de Brotas and Serra de Botucatu, San Paulo[1]; the Serra de Guarapuava, Parana[2]; and west of Rio Grande do Sul. In the northern states of Maranhão[3] and Piauhy[4] similar deposits occur; the igneous rocks are Cretaceous.

Among the deposits of the first type are those where copper ore is found in quartz veins cutting the metamorphic series, formations closely connected with pegmatite dikes.

The deposit of Picuhy is situated in Serra de Borborema, on the border of the states of Parahyba and Rio Grande do Norte, a ridge of metamorphic rocks. Here the association of the copper ore, the quartz veins, and the pegmatites younger than the Minas series is clearly seen, as pointed out in a report by Dr. Euzebio de Oliveira[5]. The veins of this deposit are scattered over a wide area. In the outcrops the ore consists mainly of carbonates, malachite, and a small amount of azurite. Small amounts of chalcopyrite and chalcocite occur among the oxidized minerals in the pits. The deposit comprises a comparatively large tonnage of ore, of a copper content below 3 per cent, in a semi-arid region, where adequate transportation facilities are lacking.

Another deposit is found in northeastern Brazil, in the State of Ceará, a few miles from the town of Viçosa. Dr. Horace Williams[6] describes this deposit as an impregnation of malachite in the mica schists belonging to the so-called Ceará series, which is comparable to the Minas series. It is not a large deposit, and the ore is of low copper content, although picked samples may run high. Similar impregnations of malachite are found in the State of Minas, in the metamorphic rocks at Tombador, near Ouro Preto, and elsewhere. None of these, however, are of commercial importance. In the State of Matto Grosso, occurrences of this type near Registro do Jaurú were reported by Castelnau[7].

All copper deposits in the State of Bahia are apparently associated with basic pyroxene-bearing igneous rocks, of earlier origin than the Minas series, and also with some overlying formations of unknown age, the Lavras series, consisting mainly of sandstones and conglomerates, and the Bambuhy series, where limestones predominate. The most important deposits in this state are situated a few miles from the town of Joazeiro, on the San Francisco River. They are not far from the river or from the railway line between Bahia and Joazeiro. The one best known, named Carahybas, consists of an extensive impregnation of chalcopyrite, in the basic rocks and in the gneiss near the contact zone. It is of great magnitude and contains about 3 per cent copper. In the outcrops the ore is weathered into malachite and chrysocolla.

Other deposits, some of which occur in limestone of the Bambuhy series, are Carnahyba, near the station of the same name; Ortigas, near Patamuté; Melancia, in the Districto de Curaçá, 20 km. from the San Francisco River; Poço de Fora; Buião; Angico and Serra de Borracha near Barro Vermelho. Some deposits have also been reported in the vicinity of the villages of Canudos, Queimadas, and Campo Formoso.

Near the village of Pedras Verdes, halfway between the city of Brotas and the San Francisco River, I have inspected a wide quartz vein cutting the sandstones of the Lavras series, with small scattered patches of malachite, formed by weathering. An extensive outcrop of igneous rocks, a few miles from Machado Portella station, in the same state, shows a slight mineralization, with a low percentage of copper in the rocks[8].

In spite of opinions to the contrary held by some authors,[9] many deposits in the State of Rio Grande do Sul may well be included among the deposits of group (*a*). Such is the opinion of Dr. Franco de Carvalho, who recently inspected these deposits.[10] They consist of irregular transverse veins in metamorphic schists, occasionally running close to conglomerates and sandstones. They are, however, quite distinct from the overlying strata of Permo-Triassic age. Basic igneous rocks, from which the schists are derived by metamorphic phenomena, are always present. That this eruptive is responsible for the metallization seems quite probable. In the outcrops the veins carry chrysocolla and other weathering minerals. At depth they consists mainly of chalcocite with phillipite, bornite, and chalcoyprite. Average copper content is about 7 per cent.

The most important and best-known deposit of the district is L. Luiz, also named Camaquan, near the river of the same name, 40 km. south of Caçapava and about 70 km. from the railway station Rio Preto. Here many lenticular veins are found, running in the direction north-south. Four of these are regular and fairly extensive. The veins cut old metamorphic rocks not far from the sandstones and conglomerates of the Santa Catharina system, Permo-Triassic, crossed by other igneous rock flowing in sheets on the top. This deposit, known for many years, was worked 40 years ago by an Anglo-Brazilian company and later by a Belgian concern. The ore was hand-sorted and the low-grade portion concentrated by wet methods. A concentrate, averaging 30 per cent copper, was smelted, and the resulting matte exported. Lack of adequate transportation facilities was responsible for the failure to make a profit.

The Seival deposit, on the Camaquan River, has also been worked on a small scale. At the other deposits in the district only development work has been undertaken. Among these are Bom Jesus, Serra dos Andrades, Primavera, Bom Jardin, Serro do Geraldo, and Serro do Martins.

Of the deposits referred to, those of the Camaquan district, Rio Grande do Sul, and the Curaçá district, in Bahia, appear to be the most promising for immediate development, especially those first named. The Camaquan ores are pyritic, and well-adapted to concentration methods. Pyritic smelting of the concentrates in water jackets, followed by converting, appears to be the

best procedure. Gold may be recovered in the slime produced by electrolytic refining of the blister. In the Curaçá district a hydrometallurgical process may be preferable. The ore may easily be hauled to the San Francisco River, where numerous suitable sites for the construction of ore-treatment plants are available.

Bibliography

[1]E. Hussak: *Centralblatt f. Mineralogie, Geologie u. Paläontologie,* 1906, No. 11.

[2]E. P. Oliveira: "Monographia Serv. Geol. e min. do Brazil," Vol. VI.

[3]L. F. Moraes Rego: "Bol. Museo Nacional," preliminary edition, Rio de Janeiro, 1930.

[4]H. Small: Publ. 32, serie I. D., Insp. Obras contra as Seccas, Rio de Janeiro, 1914.

[5]E. P. Oliveira: "Bol. do Minestrio da Agricultura Commercio e Industria," Rio de Janeiro, 1923.

[6]H. Williams: Bol. No. 16 do Serv. Geol. e mineralogico do Brasil."

[7]F. de Castelnau: "Expedition dans les parties centrales de l'Amerique du Sud executé par ordre du Gouvernement Français pendant les années 1843 à 1847 sous la direction de F. Castelnau." Paris, 1852.

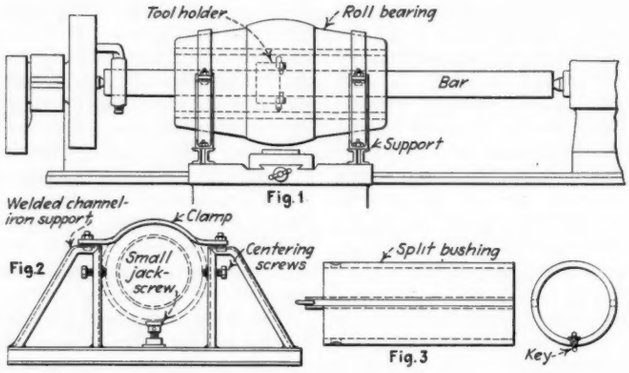
[8]H. S. Washington: *American Journal of Science,* Vol. 38, 1914.

[9]K. Scott: *Trans.* Inst. of Mining Engineers, Vol. 25, London, 1903.

[10]P. F. Carvalho: "Relatorio do Serviço Geologico e Mineralogico do Brasil," 1928.

■ ■ ■

Novel Bearing Repairs



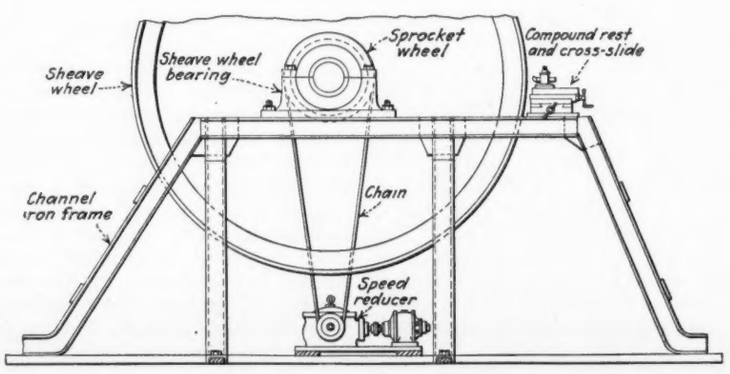
RECONDITIONING bearings of large crushing rolls is a difficult task when proper repair facilities are not available. At the machine shop of Old Dominion Company, Globe, Ariz., such repairs are successfully accomplished at a saving of time and materials by a method for babbitting and turning large roll bearings, recently developed by F. R. Kennedy, master mechanic. Frozen bushings, and boiling and blowing of the molten babbitt during pouring, are common occurrences when bearings are babbitted with the conventional solid bushing, and when an unsuitable lubricant is employed. This has been overcome by the use of a split cast-iron bushing with a long mild-steel guide key, shown in Fig. 3, and by applying Keystone Velox No. 3 grease as a lubricant for the bushing. Removal of the bushing from the cooled bearing is simple and takes only a few seconds. First, the guide key is pulled out, after which the loose bushing is easily removed by the overhead crane.

The turning of the bearings is equally simple with the lathe set-up illustrated in Fig. 1 of the accompanying sketch. Owing to the size and weight of the bearing it cannot be attached to the faceplate of the lathe; machining is therefore accomplished in the same way as in a horizontal boring mill. The bearing rests between two welded channel-iron supports bolted to the lathe apron, as shown in Fig. 2. each equipped with a small jackscrew and two setscrews, to facilitate the centering of the bearing. Additional stability is afforded by the two clamps made of ¾-in. strap iron. The adjusting of the boring-bar tools is simple and requires little time; once adjusted, a definite number of bearings may be turned with the same tool.

■ ■ ■

Turning Hoisting Sheaves

TURNING and rectifying the cable groove and tread of large sheave wheels—a procedure performed periodically at the average mine machine shop—is difficult if a sufficiently large lathe to accommodate the sheave is lacking. The mechanical department of Miami Copper, Miami, Ariz., faced with the necessity of turning several large hoisting sheaves, and having no special lathe for this purpose, solved the problem successfully with the ingenious permanent fixture shown in the accompanying illustration. Compared with the center method, the shaft of the sheave rests in two bearings such as are used on the headframe proper, thus assuring stability and eliminating vibration. The bearings are mounted on a sturdy arc-welded frame, or lathe bed, made of 6-in. channel iron, reinforced with mild-steel plates and bars. A small motor-driven speed reducer, connected by a steel chain to the split sprocket wheel on the sheave shaft, furnishes the motive power. The cross-slide and compound rest, with the tool holder, are bolted to the small frame extension, as shown.



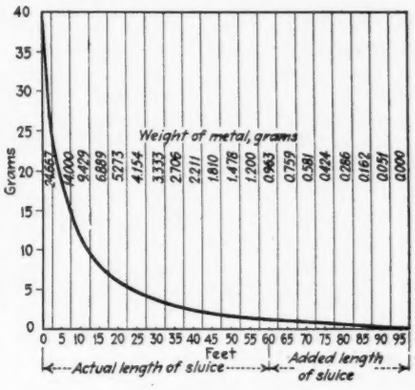
Dredge-Sluice Efficiency

B. W. Bellinger

PERCENTAGE RECOVERY is undoubtedly known with less accuracy in sluicing operations than in any other method used for the recovery of precious metals. This may be said to apply both to dredging and to hydraulic operations, although the mobility of the former makes examination of the tailing more impracticable. Much has been written and a great deal more argued about the proper length, type, grade, and amount of water that should be combined in the perfect sluice, and a rare find is a dredge master, winchman, superintendent, or clean-up man who has not his own ideas as to what constitutes the one and only proper type of riffle. Such arguments and conclusions are valueless in most instances, as the conclusions are based on undetermined premises. Each type of riffle has its place, and no one type is best suited for all conditions.

Various methods are used in dredging to determine the percentage of recovery, none of which, in my opinion, except under ideal conditions, gives the information sought. Even if gold or platinum is evenly distributed over a relatively smooth bedrock, accuracy cannot be expected in the final computations of the value per yard when economic considerations do not ordinarily permit churn-drill holes to be placed closer than 100-ft. intervals. Six-inch drill holes at 100-ft. intervals establish a ratio of the sample to the whole of about 1 to 50,000. Credit should be given the churn drill, as it alone has made the testing of placer ground, even successful dredging, possible, but absolute accuracy cannot be expected from it, though under the careful supervision of an expert driller or engineer. For this reason I maintain that any comparison of the drill logs and the amount of metal recovered by a dredge has little bearing on the efficiency of the sluices. In many instances the yardage dug by a dredge, especially in open river work, with continuous movement of gravel, is extremely difficult to determine. However, the yardage as estimated by the dredge master is invariably greater than that shown by actual measurements. Further, one must consider that at many places the bedrock is uneven, and the deposition of the metal is consequently irregular and spotty. This places additional hurdles in the path of the engineer who attempts to secure accuracy with the churn drill.

Many engineers lose sight of the fact that the criterion of efficient dredging is the percentage of recoverable metal that is recovered, and not a recovered percentage of the amount estimated by drill examination. In the district where



Curve of metal recovery

these observations were made the bedrock is uneven and the metal spotty. Drilling, often done in the open river under great difficulties, served, in my opinion, only to estimate roughly the amount of metal and to determine the channel. In many instances the drill results could have been cut in two or doubled, if checking against the recovery had any value in calculating efficiency. On bench drilling, the dredges often recovered as high as 150 per cent of the indicated metal present, and often as low as 60 per cent. These facts and a study of the reasons for them gave rise to a belief that actual dredge recoveries under normal drilling and dredging conditions cannot be placed against estimated ground content to determine the percentage of existing metal recovered. Many engineers will disagree with this view, but no dredge operator knows the actual amount of metal that goes into his hopper, and to check an unknown amount against a problematical amount, as indicated by drill logs, leaves too much to guesswork.

The practice of having the dredge master watch the tailing sluices and pan there at frequent intervals is a proper one, as it gives a comparative idea of losses. However, this means little in the determination of the actual and percentage loss or recovery. Various types of samplers might be arranged as in mill practice, placing them at the end of the tailing sluices, but economic considerations as well as mechanical difficulties must be taken into account. As to the former, one man per shift would be needed to operate the samplers, and additional laboratory expense would be entailed. The arrangement of efficient sampling devices is mechanically possible, but they would be complicated, as they would cover the entire width of the sluices, and would have to be placed aft, where little provision for machinery usually exists. This method is impracticable.

In view of these considerations and of the difficulties encountered in determining the percentage of gold and platinum actually recovered, I advanced the theory, while in the employ of a dredging company in South America, that, if the amount of platinum and gold in a sluice be weighed by short sections of the sluice, these weights could be plotted against the sluice lengths involved and a curve would result that would show the actual recovery in percentage and indicate an efficient length of sluice. Also, a comparison of results obtained using different types of riffles, different grades, and different amounts of water would be of assistance in the design of dredges and the arrangement of sluices.

I left the company soon after making the original test, so was unable to continue the experiments. As a test was made of only one sluice, the curves that might be drawn would not show a regularity that represented the result of several trials. However, the results were interesting, and they are offered for what they may be worth. The tests were made on a conventional single-decked California-type dredge having a revolving screen and belt stacker. Transverse sluices had a grade of $1\frac{1}{2}$ in. in 12; longitudinal ones, $1\frac{3}{8}$ in. in 12. The riffles were $1\frac{1}{4}$-in. angle iron over the entire table area.

With the aforesaid theory in mind, the center transverse sluice on the starboard slide of the dredge was selected for the test. The riffles were lifted on clean-up day in 5-ft. sections, and each sample was panned with the same care that would be used in panning drill samples. The longitudinal sluice, into which the transverse empties, was also treated in a like manner; and, as this sluice receives material from the adjoining transverse sluice forward, the weights of metal allotted to the sluice were in proportion to the whole as the weight of metal in the head of the sluice considered was to the sum of the weights of metal in it and the forward adjoining sluice. Thus the sluice treated was considered as one sluice 60 ft. in length. The results of the weighing are presented in Table I.

As might be expected, the one trial did not provide sufficient data from which to construct a curve without irregularities. An inspection of the figures in the table will indicate, however, that if a curve is drawn on rec-

Table I—Weight of Metals Recovered in 60-Ft. Sluice

Section No.	Platinum — Weight, Grams	Platinum — Per Cent of Total	Gold — Weight, Grams	Gold — Per Cent of Total
1	103.400	78.59	50.090	62.98
2	163.200	12.40	17.020	21.39
3	70.500	5.36	6.152	7.73
4	21.500	1.63	2.876	3.61
5	6.971	0.53	0.174	0.22
6	4.480	0.34	0.869	1.09
7	3.782	0.290	0.348	0.437
8	2.406	0.183	0.539	0.677
9	2.396	0.181	0.495	0.622
10	2.306	0.175	0.418	0.526
11	2.238	0.170	0.337	0.423
12	2.091	0.152	0.267	0.335

tangular coordinates, using the weights as ordinates and the distances from the head of the sluice as abscissas, the curve will be asymptotic and probably hyperbolic.

The gold curve offers fewer data for computation than the platinum one. The weights of gold indicate that the gold is carried farther down the sluices than the platinum before being caught. As the primary object of the dredge is the recovery of platinum, little mercury is sprinkled at the heads of the sluices, and the gold may not have been caught as quickly as it would have been with more mercury. Although the experiment does not justify as many conclusions in regard to gold as with platinum, a similar experiment could be performed on a gold dredge, and as many pertinent facts obtained.

To demonstrate the theory, data covering a hypothetical case have been assumed and a curve has been drawn. These data are presented in Table II. The curve is shown in the accompanying illustration. In plotting the curve,

Table II—Assumed Gold Recoveries

Section No.	Weight of Metal, Grams	Section No.	Weight of Metal, Grams
1	24.667	7	3.333
2	14.000	8	2.706
3	9.429	9	2.211
4	6.889	10	1.810
5	5.273	11	1.478
6	4.154	12	1.200

Length of Sluice, 60 ft.; length of section, 5 ft.

24.667 units, representing the weight of the metal recovered in the first section, are scaled off along the ordinate $X = 2.5$, the middle ordinate of the first 5-ft. section. On the middle ordinate of each section, the weight of the metal corresponding to that section is scaled off. The curve is drawn through the points on the ordinates and then continued until it intercepts the X-axis. This point is approximately at the intersection of the X-axis and $X = 95$. This may be demonstrated either mathematically or graphically, although the graphical method is probably the more practicable.

The curve follows closely the rectangular hyperbola $(X + 5)(Y + 2) = 200$, which may be solved for $Y = 0$ for the intersection. Summation of the lengths of the ordinates used to construct the curve is numerically equal to the total weight of the metal recovered, 77.150 grams. Assuming the curve to be continued to 95 ft., the middle ordinates of the assumed sections are as follows: Sec. 13, 0.963; Sec. 14, 0.759; Sec. 15, 0.581; Sec. 16, 0.424; Sec. 17, 0.286; Sec. 18, 0.162; Sec. 19, 0.051; total, 3,226. This indicates that 3.226 grams of recoverable metal were lost, but would have been recovered had the sluice been 95 ft. in length. The sluice in its actual length of 60 ft. is 95.98 per cent efficient.

The assumption that the weight of the metal which passed over the sluice is numerically equal to the summation of the lengths of the middle ordinates used in the curve, continued to its X-axis interception, is dependent for its proof on the fulfillment of two conditions. First, that the drill samples truly represent the correct proportions of the fines to the coarse metal in the ground tested; second, that the samples weighed on the individual sluice sections also contain the fine metal and the coarse metal in the same proportion as found in the drill samples. Considering the first condition mathematically, let the ground tested contain certain sizes, shapes, and weights of metal, represented by $A + B + C + D + \ldots + X$. The drill samples, if the drill tells the proper story, will contain (f) $(A + B + C + D + \ldots + X)$. If the drill samples contain (f) $(A' + B' + C' + D' + \ldots + X')$, a strong case against the churn drill prevails. Although the churn drill may not always provide the engineer with sufficient data to form conclusions within desired limits of quantitative accuracy it undoubtedly does so qualitatively. Proceeding further with this same reasoning, the section of sluice treated must contain (f'') $(A + B + C + D + \ldots + X)$ and not (f'') $(A' + B' + C' + D' + \ldots + X')$. If in any or all of the sections there appears Z, a particle of metal not appearing in the drill samples owing to unexplainable factors, or if any of the particles $A, B, C, D \ldots X$ do not appear, the theory under discussion must be false, as no relationship can be shown between recovery, drill samples, or ground tested.

Realization of the possible existence of these unfavorable conditions led to a careful microscopic comparison of both the drill samples and the sluice section pannings. No differences existed in the states of the metal from the two sources nor in their quantitative relationships. The two aforesaid conditions being fulfilled, no metal occurs that, owing to its physical or chemical characteristics, is not caught on the dredge in the same proportion that it exists in the ground, and the ordinates under the curve as constructed represent the total weight of metal passed over the sluice. These middle ordinates represent both the metal recovered and the metal not recovered, from which it is but a step to determine the efficiency of the sluice.

Another valuable adaptation is suggested: The first five feet of each transverse sluice can be cleaned independently, and the weight of metal in each used, as in the instance of the sections of the single sluice, to plot a curve. If the curve does not reach the line $Y = 0$ in the last sluice aft, losses are evidently occurring by way of the stacker. These losses may be, of course, the result of improper washing conditions in the trommel, faulty design of the trommel itself, improper speed, too small holes, incorrect slope, or insufficient diameter.

The following deductions have been made:

1. A comparison of various types of riffles and amounts of water, and of grades, might easily be made by using sluices that are contiguous or opposite to each other. Change in grade may be accomplished easily by providing a false bottom structure.

2. As the determination is independent of drilling data, it may serve to check that data and determine the relation between drilling results and possible recovery in actual operation.

3. The results obtained are as dependable as those in mill tailing sampling, as independent of the human element, and are as representative of continuous trials.

4. The method permits the dredge designer or operator to prove graphically what results are being obtained on a dredge. This would be a valuable aid in design.

5. The method permits a comparison of actual recoveries with possible recoveries, instead of with estimated possible recoveries.

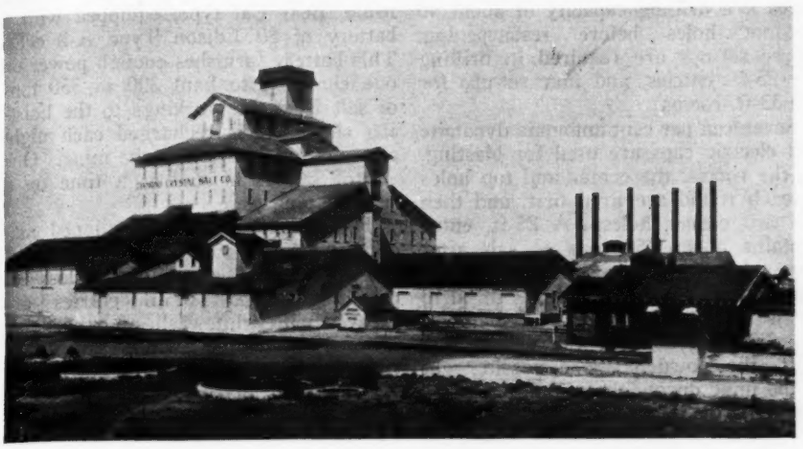
6. The method is extremely economical. No extra time is lost by the dredge. One man can secure all the samples. In the instance discussed here all the laboratory work was done without extra help.

I believe that on dredges already in operation a series of tests should be made, varying the factors of water volumes (both in the trommel and on the sluice), types of riffles, grade of the sluices, and, on gold dredges, the quantity of mercury used. A little practice in analyzing the resultant curves will enable the dredge operator to read his graphs with as much intelligence as an indicator diagram on a steam engine is read. The curve drawn from the sections at the head of each sluice will indicate at once whether or no net profits are traveling up the stacker. Ground that is to be dredged should be tested, in a similar manner, whenever possible, before metal-saving apparatus is designed and installed. The procedure is fully as important as a pilot mill is in good mill practice, and it is much more economical.

Mining Salt With Electric Equipment

Leo Reid

Electrification of underground operations is a rapidly expanding trend in the non-metallic industries that makes for increased efficiency and economy of production. At the property of the Diamond Crystal Salt Company, described here, electrified drilling, undercutting, blasting, and blockholing are employed, as well as storage-battery haulage.



Plant of the Diamond Crystal Salt Company, at Lyons, Kan.

THE Kansas salt bed is one of the largest in the world, covering an area of about 4,000 square miles, and varying in thickness from 200 to 400 ft. It lies in practically a horizontal plane, with a slight dip to the southwest. At present five mines are operating in this bed, the oldest and deepest being the Diamond Crystal, at Lyons, Kan.

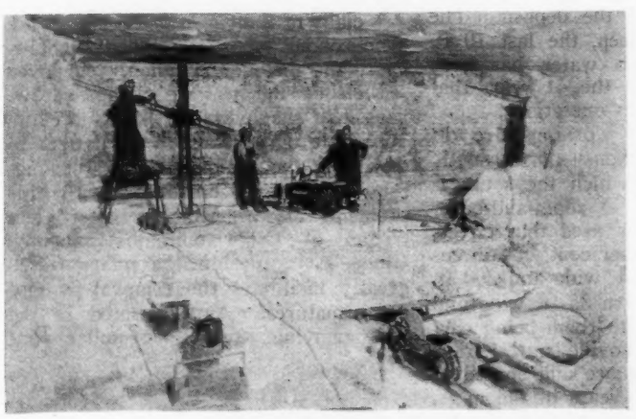
Operations at the property of the Diamond Crystal Salt Company began in 1890 with the sinking of a 1,075-ft. vertical shaft that passed through 250 ft. of salt. The shaft, in the center of a large acreage of salt land controlled by the company, consists of two 6x7-ft. hoisting compartments and one 3x7-ft. ventilating compartment. A stone and concrete foundation protects the top of the shaft and supports the headframe.

The first 30 ft. of the shaft, in hard clay free of water, is poured concrete. The next 30 ft. is in a sandy clay that yields more than 500 gal. of water an hour. Inasmuch as the sandy clay is underlain by 300 ft. of soluble material, the water had to be excluded from the shaft. To accomplish this the shaft was therefore enlarged just above the soluble material to 9 ft. 6 in. by 17 ft. 10 in., providing space for an outer and inner lining, with puddling between to keep the water out of the shaft.

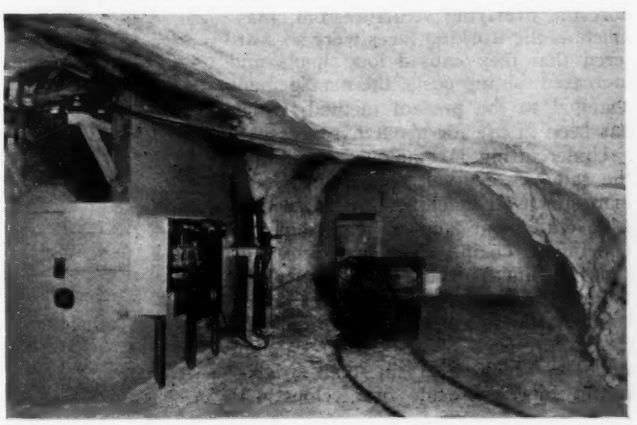
As sinking progressed the outside lining was carried down and firmly held in place by temporary buntons or crosswise timbers. Double corner strips were employed, and each twelfth set of 4x12-in. timbers was used as a bearer set. A stratum of dark shale containing thin layers of limestone was encountered at a depth of 60 ft., through which the shaft was cut by hand. Ten feet below the top of the shale the dimensions were increased 4 ft. on all sides, the space tapering at an angle of 45 deg. This space was timbered and filled with cement. Eight 2-in. pipes were inserted through the timbers immediately above the cement, to carry the water into the shaft while the cement was being placed. A second cement ring was constructed 6 ft. below the first ring. A heavy 12x12-in. bearer set was placed, and a 4-in. lining inside of the set. The space behind the lining was filled with cement.

The eight drain pipes were just long enough to extend through the holes in the lining. Permanent buntons were installed to replace the temporary buntons, which were taken out a few at a time. When the cement had been poured between the two linings, a 15-in. watertight wall was formed. After the shaft had been timbered in this manner up to 5 ft. above the water-bearing stratum, and the pipes had been plugged, it was rendered dry. From this point to the bottom, the shaft was timbered with 4x12-in. timbers, placed edgewise and skin to skin.

A red, water-bearing sandstone was encountered at a depth of 130 ft., below

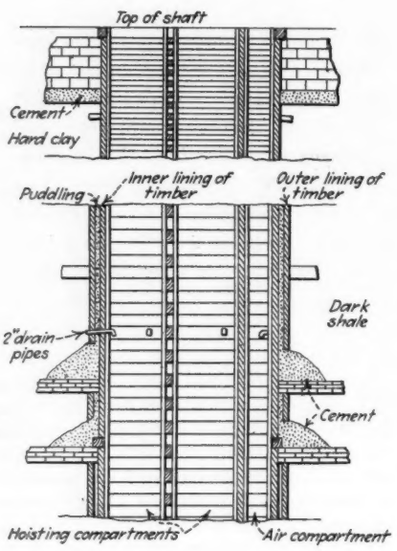


Undercutting and drilling in one of the rooms



Underground battery-charging station

which a water ring was constructed that held the water accumulation of eight or ten days. Below this point blue shale was encountered, and no further trouble was caused by water. When the salt was reached inside dimensions of the shaft were increased to 17 ft. x 18 ft. 8 in.,



Method of sinking through water-bearing strata

to provide space for an inner lining and puddling, should it be required to keep water from the salt. Fourteen workable seams of salt were penetrated, and a decision was made to work an 18-ft. bed near the bottom of the deposit. The shaft is 1,075 ft. deep, the last 10 ft. being a sump. No water has been hoisted from this in the 41 years that the shaft has been in operation.

The underground workings are divided into four sections—north, south, east, and west—of which the south is now being worked. A room-and-pillar method of mining is used that effects an extraction of 65 per cent. Main entries are driven 25 ft. wide and 200 ft. apart. The rooms are 35 ft. wide and 170 ft. long, each fifth room being carried forward to provide an airway. Pillars are 40 ft. square and spaced at 40 ft. In the early years of the mine, pillars 100 ft. square were left to support the overlying structure, but, inasmuch as the working faces were so scattered that they caused long hauls and increased mining costs, the management changed to the present method, which has been in use for about five years.

Undercutting is employed in mining the salt. A 220-volt d.c. 50-hp. Goodman shortwall machine is used, with a 6-ft. cutter bar and an eight-position Cincinnati chain. The machine cuts about six lineal inches per minute, owing (1) to the hardness of the salt, which has a hardness number of 2.5, and (2) to the presence of anhydrous calcium sulphate, which occurs in small streaks. Cutter bits are made of Cyclops 4-P self-hardening steel. In drilling the salt three 220-volt d.c. Scranton drills are employed. The drilling tool is a $1\frac{1}{2}$x $\frac{5}{8}$-in. coal-type auger, 9 ft. long, with a special coating of tungsten carbide that gives it a drilling capacity of about 40 six-foot holes before resharpening. Three set-ups are required in drilling the 25-ft. entries, and four set-ups for the 35-ft. rooms.

Seventeen per cent ammonia dynamite and electric caps are used for blasting. In the rooms, the center and top holes of each round are fired first, and then the two corner holes. A 25-ft. entry contains about 150 tons of salt after a round is fired. A 220-volt d.c. Van Dorn standard drill, with $1\frac{1}{2}$-in. drill bit, is used in blockholing large lumps. All firing is done at the end of the shift, the powder smoke passing out of the mine during the night.

Ventilation of the workings is effected by the pumping action of the hoisting cages, which forces air down the shaft and to the working faces, through about five miles of airway. The air then travels to the air compartment in the shaft, which is surmounted by a 100-ft. stack above the collar of the shaft.

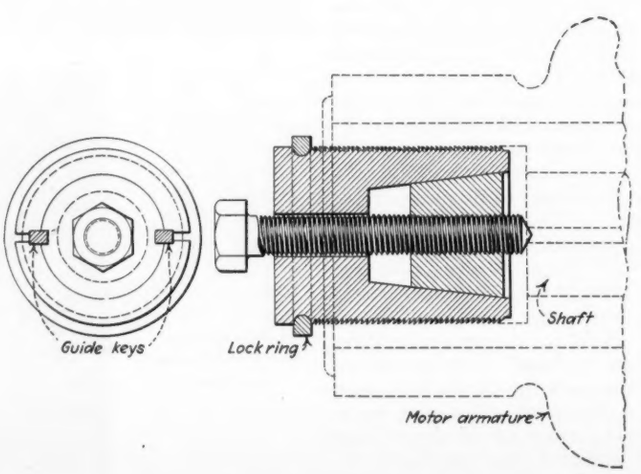
The broken salt is loaded into 2-ton steel cars by Mexican labor and transported to the hoisting shaft by a Mancha Mule, Bear Cat type, equipped with a battery of 80 Edison Type A-8 cells. This battery furnishes enough power on one charging to haul 300 to 350 tons of salt from the workings to the hoisting shaft. It is recharged each night at a charging station in the mine. One car of salt is hoisted at a time on a self-dumping cage.

The mine has a well-equipped machine shop and supply room that limit breakdowns to a minimum loss of operating time. Main entries are sprayed with whitewash, and the floors covered with fine, white salt. The tracks are level and straight, with a slight downgrade to the hoisting shaft. All switches are equipped with electric red and green signal lights. An emergency first-aid station is maintained underground. A constant temperature of 72 deg. F. prevails in the mine throughout the years.

■ ■

Motor-Armature Puller

REMOVING motor armatures, especially of the General Electric A.T.I. synchronous type, is a difficult job because the methods commonly employed —such as the use of clamps, drawbars, and the hydraulic press—are not applicable on account of the danger of damaging the commutator and the motor windings. Confronted with this problem, M. F. Murphy, chief electrician of Old Dominion Company, Globe, Ariz., designed a puller which greatly facilitates the removal of motor armatures. As illustrated in the accompanying sketch, the puller consists of a conical, hollow, threaded core, controlled by a steel tension bolt and guided by two small keys, over which the half segments of the puller shell are held together by a mild-steel lock ring. The device is applied in the following manner: The shell is inserted into the opening at the commutator end of the armature, and the tension bolt turned until contact is made with the motor shaft. Further turns of the bolt raise the core, which presses the two fang-like tempered segments into the mild steel; additional pressure then detaches the armature from the motor shaft.



PLATINUM MINING in Sierra Leone

J. D. Pollett

ALTHOUGH the geological features of Sierra Leone were known in outline prior to 1926, no mineral deposits of commercial value had been discovered. About the middle of that year, however, Dr. N. R. Junner, the present director of the Gold Coast Geological Survey, upon request by the Sierra Leone government, was authorized to make further investigations of certain selected areas, with discovery of such deposits in view. So great was the success of this investigation that within two months Dr. Junner had succeeded in locating deposits of high-grade hematite in payable quantities, as well as of alluvial gold and platinum. A further result of this work was the re-establishment, during 1927, of a geological survey in Sierra Leone.

Platinum in the native state occurs in the gravels of streams draining the hills forming the peninsula of Sierra Leone. To a limited extent it has also been found in beach gravels in certain coast localities. The most promising deposits are in the vicinity of York, more specifically in the streams flowing into Whale River on its northern banks. Here the metal occurs as small nuggets, pitted and water-worn grains, delicate dendritic crystalline growths, and dust. Occasionally cubic crystals are found. Many of the small nuggets and water-worn grains have a peculiar brass color. The largest nugget yet recovered weighed 12½ dwt., and numerous nuggets ranging between 5 and 10½ dwt. have been found. These larger nuggets are invariably well water-worn. An interesting feature is the presence of practically non-water-worn, delicate dendritic crystalline growths of platinum in gravels that also contain well-rounded grains of the metal. This dendritic non-water-worn form, however, is rarely seen in fragments larger than ½ dwt. Another noticeable feature is the small percentage of platinum dust. An analysis made by the Imperial Institute, London, of crude platinum obtained from Big Water, near York, gave the following results: Platinum, 87 per cent; osmiridium, 1.3 per cent; palladium, 2 per cent; and iron, 9.9 per cent.

The hills of the peninsula have been carved out of a large basin-shaped sheet of basic igneous rocks, the central and western part of which is cut off on the seaward side. "The rocks forming the main intrusion have a stratiform arrangement, and show a well-defined primary banding (fluxion structure). Those in the lower part of the exposed

Coastal section of Sierra Leone, with platinum area

part of the intrusion are mainly olivine-rich troctolites, and they are a little more basic than the rocks near the top of the sheet. The rocks are not arranged in simple gravitative differentiation layers. The oldest and by far the most abundant rocks in the intrusion are well-banded medium-grained troctolites, and ordinary and olivine-bearing gabbros and norites. While still hot these rocks were invaded by masses—of relatively small size compared with the banded rocks—of coarse-grained gabbro and norite (including olivine-bearing types) with some peridotite and a little dunite and gabbro-pegmatite. These rocks are either free from banding or are poorly banded. The large sheet-like body of coarse-grained anorthosite near York Pass appears to be intrusive into the banded rocks and may have been formed at this stage. Bands of anorthosite and anorthositic gabbro, associated with titaniferous iron ore and some beerbachite, form a well-marked 'horizon' in the lower part of the intrusion between Waterloo and Freetown. Thin bands and schlieren of anorthosite occur in many other places in the banded gabbros. Concentric and radial tension fissures were developed by the sagging of the central portion of the cooled intrusion, and many of these fissures were filled in with small dikes of beerbachite, dolerite, and micropegmatite. The last-named rock occurs in insignificant amounts and represents the residual magma squeezed out when almost the whole of the intrusion had solidified."[1]

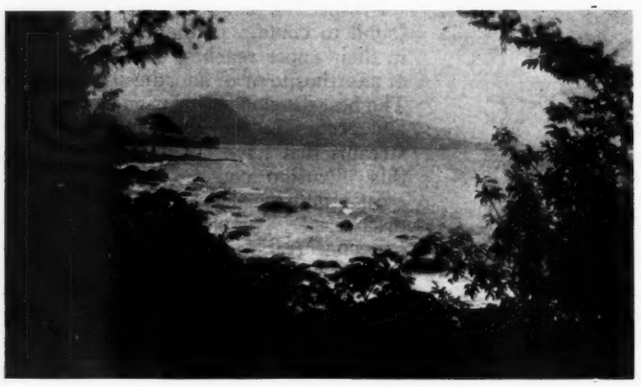
Prospecting has shown that all streams found to contain platinum cut through, in their upper reaches, either intrusions of anorthosite or of anorthositic gabbros. The best developed intrusion of anorthosite occurs in the York area, and the streams that have cut most deeply into this intrusion contain the richest and most promising deposits of platinum yet discovered. The platinum is sporadic in its concentration, but in pockets it has been found to run as high as 2 oz. to the yard. Moreover, in each stream the presence of the metal in appreciable concentration has been found to end abruptly at a point within the anorthosite outcrop but near its base. Non-water-worn platinum has been discovered in the eluvium, and in small gullies, on the steep anorthosite slopes above the streams where the deposits end. Occasionally, small particles of ilmenite are found adhering to the platinum from the main deposits, and a characteristic feature of the anorthosite in this region is the occurrence of blebs of ilmenite in the rock. These data support the theory that the source of the platinum is in the anorthosite intrusion. Several assays of the rocks from this area have been made. Although most of the results indicate the presence of platinum, none has shown a concentration of more than 6 grains to the ton.

Twenty-two square miles of ground were taken out in exclusive prospecting licenses in 1928. Toward the end of 1929, mining was commenced in the York area. During 1929, 26 oz. (troy) of crude platinum was produced, valued at about £263. For 1930, the corresponding figures were 548 oz. and £3,940; for the first six months of 1931, 469 oz. and £2,047.

Owing to the rocky nature of the streams and the many large boulders in the wash, only methods involving manual labor have been found practicable in working the richer parts of the deposits. A marked concentration of the platinum on bedrock, and in the bottom foot of wash, simplifies the mining. The overburden is removed and thrown to one side, and the wash is extracted and

[1]Junner, H. R.: "The Norite of Sierra Leone." Communication No. 43 from Vol. II of the Compte Rendu, XV International Geological Congress, South Africa, 1929.

Sluicing platinum gravel, Big Water stream



Coast of Sierra Leone peninsula, looking south from Sussex

Natives panning platinum concentrate from sluice boxes, Big Water stream

head-panned to sluice boxes. A grizzly at the head of the box removes the larger stones. The wash in the box is kept from clogging by constant shoveling toward the head of the box, the concentrates being retained by means of riffles. A feature of the concentrate is the presence of large amounts of black sand, consisting mainly of ilmenite and titaniferous magnetite. On account of this sand, the boxes must be cleaned up at least once a day, and, in many operations, more often. The concentrate is removed from the box after cleaning and carefully panned by skilled native labor. As they appear, the coarser pieces of platinum are removed by hand picking; the fines, which form only a small percentage of the whole, are recovered as the final product. A hand magnet is employed to remove any residue of black sand, but care is necessary in this operation, as some of the platinum is distinctly magnetic, whereas much of the black sand is not.

The Sierra Leone government has imposed a 5 per cent ad valorem export tax on platinum. For the purpose of computing this value the crude concentrate is assumed to contain 75 per cent platinum. All of the platinum produced in Sierra Leone is shipped to England, where it is sold.

Development of the platinum field has been retarded by the present world-wide depression and the prevailing low prices of the platinum metals. In 1926, when the field was discovered, platinum was worth £23 an ounce; in 1929, when mining commenced, the price had fallen to £13. The decline continued until June 8, 1931, when quotations suddenly rose from £5 to £8 an ounce, a price which may be hoped to represent the low point. This fall in price has resulted in mining on a limited scale, confined to the richest areas of the deposits only. Those in the vicinity of York could be worked at a profit even if the price was to fall slightly below that of gold, but the remainder of the field can probably not be developed on any scale unless the price is stabilized in the neighborhood of £10 an ounce.

Ilmenite concentrate, as already stated, is obtained as a byproduct during the working of the platinum deposits. Samples have recently been examined by the Imperial Institute, London, in regard to their possible use in the manufacture of titanium white, and a favorable report has been received. Although assays of the original concentrate showed 12 dwt. of platinum metal to the ton, the slime from the same concentrate after treatment for the preparation of titanium pigment gave a content of platinum metals of about 1½ oz. to the ton. Treatment of this concentrate to recover platinum content may be practicable if the concentrate may be used in the manufacture of titanium white. Attention has already been drawn to the fact that the streams containing the richest platinum deposits drain into a flat, sandy tidal estuary known as Whale River. The sands of this river are almost certain to contain at least a small amount of platinum; but, unfortunately, the low price of platinum has discouraged investigation. The practicability of working this deposit and similar low-grade deposits, such as those found in the estuaries of the Toke and No. 2 rivers, may determine the importance and life of the field. Analyses of concentrates of black sand from these deposits show the following percentages of titanium dioxide: Whale River, 52.5 per cent; Toke River, 50.1 per cent; Orugu River, 49.9 per cent.

In addition to the deposits near York and Toke, platinum has been recorded near Waterloo in tributaries of the Benguema stream; in the tributaries of the Orugu River, which drains an anorthosite outcrop near the village of Regent; and in a small stream near Adonkia. Little or no prospecting has been done in these areas.

Finally, one more factor has to be considered in estimating the future importance and life of the field. Will the platinum be traced to its source, and will it be found in sufficient concentration to justify rock mining? The probability that the platinum is derived from the anorthosite sheet has already been discussed, but whether it occurs as a dissemination throughout the entire mass, or whether the main source is confined to a definite belt within the sheet, remains to be discovered. That the better price for the metal now prevailing may lead to increased activity in the field, and that the work may ultimately reveal the platinum *in situ*, may safely be considered to be well within the range of probability.

Consumption of Flotation Reagents

THE large increase in the tonnage of ore treated by flotation in 1929 was partly attributable to increased output from existing plants and partly to the adoption of the method in new plants. Expressed in pounds per ton of ore treated, the total reagents consumption decreased over 4 per cent. The trends indicated are: (1) decreased consumption of frothers; (2) substitution of synthetic collectors for distillation products; (3) more extensive use of butyl and amyl xanthates; (4) introduction of aliphatic dithiophosphates; and (5) more extensive use of the alkaline circuit.

Table I gives the tons of ore treated and concentrates produced by flotation, gravity concentration, and combination of the two methods during 1929. Most of the copper ore concentrated by combined gravity and flotation methods was treated in plants in the Michigan district. Of the lead and zinc ores treated by this combination method the majority came from the southeastern Missouri lead belt and the Tri-State district.

Table I—Ores Treated and Concentrates Produced

Class of Ore Treated	Ore Treated, in 1,000 Tons: Straight Gravity	Combined Gravity and Flotation	Straight Flotation
Copper	877	11,711	47,010
Copper-lead	.....	48	264
Lead	418	6,370	391
Lead-zinc	34	1,411	3,355
Zinc	1,865	13,650	925
Gold-silver	20	87	177
Totals	3,214	33,277	52,122

	Concentrate Produced, in 1,000 Tons: Straight Gravity	Combined Gravity and Flotation	Straight Flotation
Copper	18	413	2,520
Copper-lead	.....	3	31
Lead	26	367	70
Lead-zinc	17	139	721
Zinc	493	625	130
Gold-silver	2	7	8
Totals	556	1,554	3,480

Table II gives the reagent consumption for all ores in 1929. Frothing reagents were used for 98.44 per cent of the ores and old tailings treated. Pine oils, cresylic acid, and orthotoluidin were the only frothers reported. The consumption decreased from 0.155 lb. per ton of ore in 1928 to 0.144 lb. in 1929. Ethyl xanthates were the most widely used collecting reagents in 1929, followed by coal-tar creosotes and dicresol-dithiophosphoric acid. Alkalies were used for 96 per cent of the total ore treated, compared with 94 per cent in 1928.

Copper Ores — The figures given in Table I indicate a continuation of the trend toward straight flotation methods. Pine oils continued to be the chief frothing reagent, followed closely by cresylic acid. Although the total tonnage of ore increased, the actual amount of pine oils decreased, resulting in a lower per-ton consumption. Total consumption of cresylic acid showed a slight increase. Consumption of distillation collectors dropped more than 20 per cent, in conformity with a marked increase in the consumption of synthetic collectors, chiefly xanthates and dithiophosphates. No acid was reported used during the year except for two plants treating iron-copper ore; practically all of the ore was treated with lime, the consumption of which was about the same as in 1928. Sodium sulphide consumption showed a decided decrease, but no marked change was noted in the use of depressing agents. Flotation, used in conjunction with gravity concentration, was applied successfully to native copper ores. Reagent combinations used for these ores are similar to those used for sulphide ores, the chief difference being the lower alkalinity requirement and the more general use of sodium carbonate in preference to lime. Complete metallurgy from 30 plants using straight flotation showed a concentration of 1:18.92.

Lead Ores — Several important changes in reagent consumption took place. Pine oil and cresylic acid were the only frothers reported, and both of these were used in larger quantities than in the previous year. Distillation collectors showed a decided decrease, with a corresponding increase in the consumption of both ethyl and amyl xanthates. A large variety of dithiophosphates was reported, but the total consumption was about the same as for the previous year. Total consumption of collectors showed a decrease compared with 1928. Use of sulphuric acid

Table II—Reagent Consumption in Treatment of All Ores

	Reagent Consumption: Total in 1,000 Lb.	Lb. per Ton Ore
I. Frothers:		
Pine oils	5,113	0.112
Cresylic acid	4,137	0.156
Orthotoluidin	33	0.064
Total frothers	9,283	0.144
II. Collectors:		
1. Distillation products:		
Coal-tar creosotes	1,416	0.137
Coal-tars	30	0.079
Wood-tar creosotes	120	0.028
Pine-tar oils	3	0.193
Petroleum products	173	0.041
Blast furnace oils	591	0.069
Water-gas tars	12	0.783
Total	2,345	0.124
2. Synthetic products:		
Xanthates:		
Ethyl xanthates	4,107	0.107
Butyl xanthates	194	0.054
Amyl xanthates	283	0.026
Dithiophosphates:		
Dicresol-dithiophosphoric acid	611	0.045
Sodium dicresol-dithiophosphates	209	0.019
Sodium diethyl-dithiophosphate	308	0.017
All other dithiophosphates	33	0.889
Benzyl mercaptan	1	0.021
Thiocarbanilid	154	0.033
Alpha-naphthalamine	23	0.104
Total	5,925	0.091
Total collectors	8,270	0.126
III. Acids and alkalies:		
1. Acids:		
Sulphuric	12,099	22.030
2. Alkalies:		
Sodium carbonate	4,188	0.406
Sodium hydroxide	8	0.084
Lime	227,329	3.830
Cement	3,072	3.435
Total alkalies	234,597	3.735
IV. Other inorganic reagents:		
1. Sulphidizing:		
Sodium sulphide	2,589	0.713
2. Activating:		
Copper sulphate	6,723	0.627
3. Depressing:		
Cyanides	1,810	0.072
Sodium sulphite	814	0.819
Sodium silicate	312	0.087
Zinc sulphate	2,850	0.407
Trisodium phosphate	18	0.043
Total depressing	5,804	0.213
4. Miscellaneous:		
Aluminum sulphate	15	0.005
Calcium chloride	93	0.580
Sodium chloride	103	1.316
Sodium sulphate	20	0.007
Sulphur	2	0.005
Turpentine	2	0.023
Linseed oil	1	0.010
Total reagents	279,602	4.275

Table III—Summary of Reagent Consumption

	Copper	Copper-Iron	Copper (Native)	Copper-Lead	Lead	Lead-Zinc	Zinc	Gold-Silver
Ore treated, thousand tons	51,514	481	2,087	312	4,519	3,693	2,529	269
Number of plants	36	2	4	9	34	43	109	31
Reagents (pound per ton of ore):								
I. Frothers	0.143	0.266	0.129	0.080	0.129	0.178	0.151	0.130
II. Collectors:								
1. Distillation	0.123	0.094	.....	0.090	0.012	0.315	0.118	0.471
2. Synthetic	0.066	0.301	0.073	0.253	0.135	0.280	0.180	0.175
III. Acids and alkalies:								
1. Acids	.....	24.545	.....	.....	7.254	.....	0.573	0.018
2. Alkalies	4.203	7.215	0.257	3.253	0.719	2.358	2.652	2.288
IV. Other inorganic reagents:								
1. Sulphidizing	0.218	.....	.....	1.278	4.412	0.412	0.031	.....
2. Activating	.....	0.729	.....	0.003	0.072	0.989	1.010	0.435
3. Depressing	0.056	.....	.....	1.307	0.149	1.140	0.067	0.143
4. Miscellaneous	0.008	.....	.....	.....	0.012	0.822	0.010	.....
Total reagents	4.465	32.901	0.458	3.482	1.580	4.827	2.458	1.882

Abstracted from Report of Investigations No. 3112, U. S. Bureau of Mines, by T. H. Miller, associate metallurgist, U. S. Bureau of Mines, Salt Lake City, and R. L. Kidd, professor of ore dressing, University of Utah, Salt Lake City, Utah.

was reported by one plant treating oxidized ore. Alkali consumption was much higher than in 1928, with lime the chief reagent in this class. A marked increase was also noted in the use of sodium sulphide.

In the treatment of lead-zinc ores many changes were reported. A large increase in the consumption of cresylic acid and a decrease in the consumption of pine oils caused a slight increase in the per-ton consumption of frothers. Large decreases were reported in the use of wood-tar creosotes and ethyl xanthates, and an increase in the consumption of dithiophosphates was noted, resulting in a decrease in the per-ton consumption of all collectors. A large increase in the consumption of sodium sulphide was due chiefly to the use of this reagent at one plant in the flotation of pyrite.

Zinc Ores—Reports from 109 plants showed about the same consumption of frothers, but a marked increase in the per-ton consumption of collectors, especially coal-tar creosotes, xanthates, and dithiophosphates. Frothing as well as collecting reagents were used in all plants reporting; also copper sulphate, the use of which increased slightly. Consumption of alkalies showed a marked decrease.

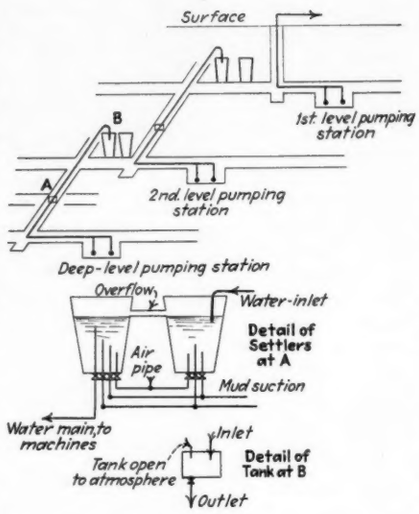
Metallurgical data from 31 plants treating gold and silver material were decidedly incomplete. Successful concentration of this class of material depends chiefly on a high recovery of the base-metal minerals with which gold and silver are associated, and the selection of effective flotation reagents will depend on the characteristics of these minerals.

A summary for the reagents used for the different metals is compiled in Table III.

Deep-Level Pumping

AN ESSENTIAL FEATURE in laying out a gold mine, where water is raised from a depth of 6,000 ft., is a suitable underground storage for clear water used in drilling operations, as well as an adequate water supply for the reduction plant, writes A. Leyland, of Johannesburg, South Africa. Suspended matter, and acidity or alkalinity of the water, must be taken into consideration in the general design, in the selection of suitable machinery, in order that corrosion and abrasion may be minimized and accumulations of silt prevented.

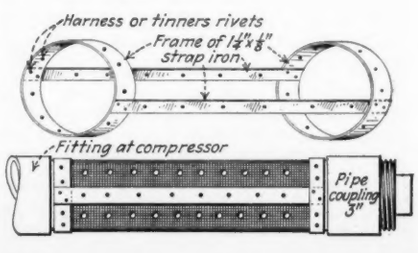
Recent developments in underground pumping at the Nourse Mines, Ltd., Transvaal, South Africa, illustrate the success achieved by a proper layout and the use of up-to-date machinery. As illustrated in the accompanying sketch, pump stations, equipped with spare units, are placed at different levels, to insure a uniform head on each unit and to prevent any possible interruption in pumping operations. To obtain a supply of clear water for drilling, two convenient stopes, or dams, are chosen. The muddy water from the adjacent levels, as well as that pumped from lower levels, flows into the first stope, where most of the suspended matter is dropped, a fairly clear water overflowing into the second stope. The two stopes have storage capacity for four drilling shifts, and are fed continuously to prevent any possibility of water shortage. Clear water for the drilling machines is obtained from a supply main taken up about 50 ft. inside the second stope. Accumulated sediment is removed by two pipes, with variable inlet columns, inserted into the bottom of each stope and connected to the suction ends of the pumps. The high-pressure air line, available at each stope, is used to stir the deposited mud so that it may be pumped to the surface. With this arrangement, continuous pumping service is assured, as one or the other of the inlet connections is always clear. The water is raised to the surface in three steps, each pump station operating against a head of about 2,500 ft. As the pressure of the water used for drilling should not exceed 50 lb. per square inch, small tanks, open to the atmosphere, are installed along the main supply line, at points chosen to give the desired pressure.



This arrangement offers the advantages an adequate supply of water with a negligible amount of suspended matter, for underground drilling operations, and an efficient method of pumping surplus water to the surface. Samples of water from stope No. 2 contain about 0.04 per cent of suspended matter. To reduce the acidity of the water to a minimum, and protect the machinery against corrosion, calculated amounts of lime are added to the water at lime stations in the water runways on each level. Hard-bronze pump chests, complete with removable valve seats and valves, do much to reduce abrasion when mud is pumped. The scale which may have formed is removed during the pumping of mud, which is done once a week. This operation adds to the efficiency of the plant, removes accumulated sediment, increases the amount of clear water, and aids in reducing operating cost.

Compressor Suction Strainer

Accumulation of waste and other foreign material in compressors is easily prevented by the use of the improvised strainer shown in the accompanying sketch, writes Thomas C. Hulton, master mechanic, Cia. Minera Chambas, Abras Grandes, Cuba. Ordinary window screen is fastened to a frame of $1\frac{1}{4}$x$\frac{1}{8}$-in. strap iron with harness rivets used for repairing miners' belts. This frame, shown in Fig. 1, is slipped over a pipe of suitable dimensions (Fig. 2), drilled to the same area as the pipe section, and held to the suction pipe by a coupling, put on just tight enough to hold, so it may be removed easily and the screen taken off and washed.



Quarrying and Transporting Limestone in Canada

M. F. Goudge

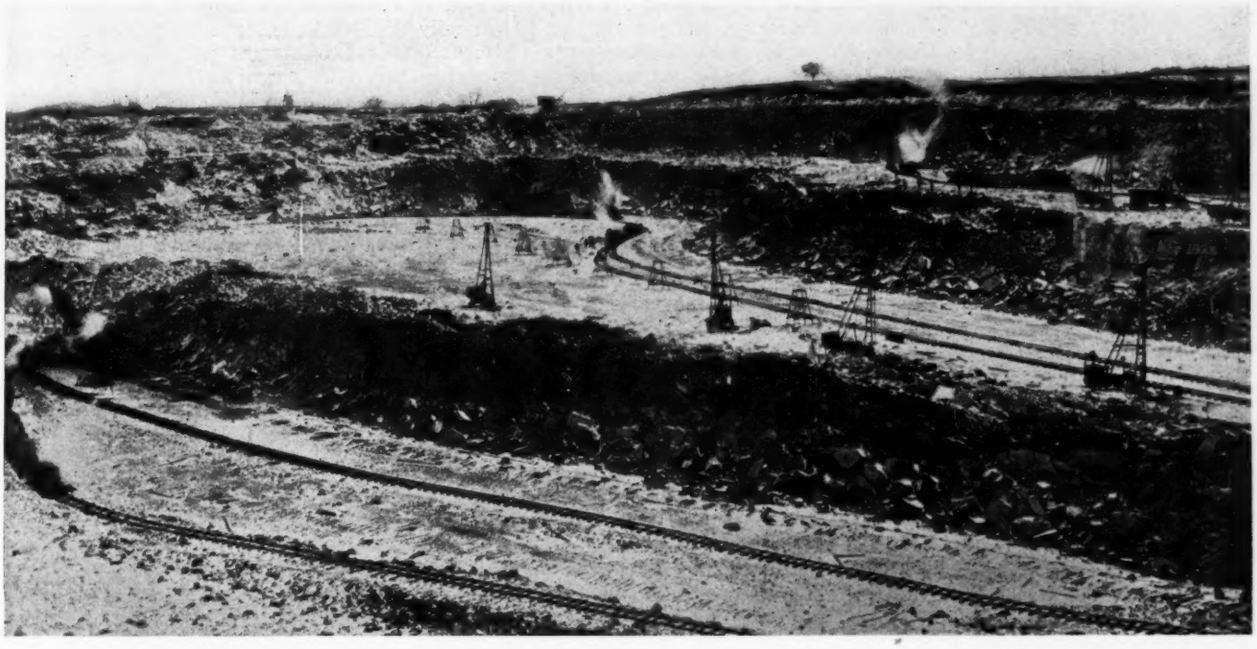


Fig. 1—West quarry, Dundas. Three faces were being worked here when this picture was taken

THE HISTORY of the Dundas quarry of the Canada Crushed Stone Corporation, near Dundas, Ontario, affords an interesting illustration of the progress made in quarry technology by the crushed-stone industry in Canada during the last two decades. Since the quarry was opened in 1905 it has been worked by many different methods. At the outset steam tripod drills were used, and the broken rock was loaded by hand into horse-drawn dump carts. In time the tripod drills were replaced by churn drills, and the dump carts by steam locomotives and side-dump cars running on a narrow-gage track.

Coincident with the installation of the steam transportation system, hand loading was superseded by steam-shovel loading. The first steam shovels purchased were on railway mountings; later these railway mountings were replaced by traction-wheel mountings and these in turn by crawler trucks. The latest installation is an electric shovel of the full-revolving type, mounted on crawler treads, and plans are now completed for the electrification of the quarry transportation system. Within the above specified period, production of crushed stone per man employed at the Dundas quarry has risen from 15 to 45 tons per ten-hour day.

The history of the quarry is not without incident. In April, 1922, just at the beginning of the shipping season, the crushing and screening units were almost totally destroyed by fire. This was a major catastrophe, but reconstruction was undertaken with the efficiency which characterizes all the operations of this company, and within fifty working days a new plant, constructed throughout of concrete and steel, had commenced production.

Favored with high-grade stone, continuity of skilled management, and an excellent location in one of the most populous parts of Canada, the enterprise has expanded from a small-scale operation having a daily capacity of only 250 tons of crushed stone, into one of the largest of its kind in the Dominion, with a present daily capacity of 4,500 to 5,000 tons.

The quarry is situated on top of the Niagara escarpment above the town of Dundas, Ontario. At this point the escarpment is 400 ft. high. The crushing and screening plant is built on the terraced face of the upper part of the escarpment, and full use is made of gravity in the processing of the stone. The total drop from the top of the primary crusher to the base of the stockpile is 255 ft.

Sidings from both the Canadian National Railway and the Toronto, Hamilton & Buffalo railway are constructed to the plant. From the Canadian National siding an inclined track 1,600 ft. long and rising on a 16 per cent grade has been constructed to the quarry. Freight cars loaded with quarry supplies are pulled up this incline by an electric hoist. A system of paved highways enables shipments of crushed stone to be made by motor trucks to the city of Hamilton, 5 miles distant, and to other near-by markets.

The rock quarried is a hard, brownish-blue Silurian dolomite, which occurs in flat-lying beds 6 to 24 in. thick. Nodules of black chert are noticeable at certain levels. Beneath the hard dolomite, and thus limiting the depth to which the quarry may be worked, is a soft shaly dolomite. At the western end of the property a face of 70 ft. of hard dolomite free from shale is worked, but at the eastern end the shaly zones come to within 25 ft. of the surface and thus restrict the quarry face to that height.

Operations are carried on in what practically amounts to two separate quarries separated by an area where the soil is so deep that it is more economical to use the space which it

Prepared with the approval of the Deputy Minister of Mines, Canada.

Fig. 2—Gasoline shovel loading soil to motor truck

occupies as a soil dump than to remove it to obtain the stone beneath. At the brink of the escarpment between the two quarries is the crushing plant. The west quarry has been worked over a length of 1,800 ft. east and west and across a width of 1,500 ft. The east quarry is semicircular, with a base of 1,000 ft. Both faces are being worked to the north or away from the edge of the cliff. The country is comparatively level, but the surface of the rock is not, having been in many places furrowed and plucked to unequal depths by glacial action, especially at the west quarry. In the immediate locality of the workings the soil over the rock increases in depth away from the edge of the escarpment, so an increasing overburden has to be removed as the quarry faces are advanced to the north.

Stripping

The soil overlying the dolomite is a hard clay, like hardpan. It is from 4 to 25 ft. deep, averaging 15 ft. It is hard to excavate, but when placed on the dumps the loosened material flows readily when wetted by rain. When the material was transported to the dumps by rail, much trouble was experienced in wet weather by the edge of the dump suddenly slumping down and carrying the tracks with it. These troubles were overcome by transporting the clay by motor trucks instead of rail cars and by a system of grading and maintaining the surfaces of the dumps.

Stripping is now done by a 1-yd., full-revolving, gasoline-driven, Osgood shovel mounted on crawler treads which loads the clay into self-dumping, steel-bodied General Motors trucks each of which holds 4 loose cubic yards of earth (Fig. 2). The success of the truck transportation system depends on proper maintenance of the dumps and also upon short hauls. In this quarry the longest haul is 800 ft. The dumps are fan shaped, and a gentle uphill gradient is carefully maintained from the base of the dump to the outer edge where fresh material is deposited. Two men are employed in maintaining this sloping surface and in filling in any ruts which develop. This care makes the soil dumps self-draining, and no trouble is experienced with the heavy trucks getting mired.

With the 1-yd. shovel and two trucks an average of 600 cu.yd. of clay can be moved in a ten-hour day, provided the haul to the dump is under 500 ft. For longer hauls an additional truck is employed.

At the close of the quarry season, if necessary, one of the shovels usually employed in handling rock is also used for stripping the overburden.

Drilling

Restrictions imposed by the near-by town of Dundas against large blasting operations have caused special quarry methods to be employed. In the west quarry the face is worked in two benches, the lower one 22 ft. high and the upper one varying from 28 ft. in the east end to 50 ft. in the west end. A single 25-ft. face is worked in the east quarry.

The primary drilling is done with nine Sanderson Cyclone, size 14, electric churn drills, each run by a 15-hp. slip-ring motor (Fig. 3). The string of tools on each drill weighs 1,250 lb. and consists of a 2-ft. rope socket, an 18-ft. sinker bar, and a 5-ft. bit, all joined by tapered thread joints. The bits used are modified forms of the ordinary bull bit. The cutting edge is $5\frac{5}{8}$ in. across. They are sharpened and dressed by an Armstrong bit sharpener fitted with special dies. An average of 40 ft. is drilled by each bit before resharpening is necessary.

The drills are operated at a rate of 58 drops per minute in solid rock and at half this rate in shattered stone. Average footage drilled is 30 ft. per ten-hour day, including moving. The holes are carried to 2 ft. below the floor level in each bench. Only one operator to each drill is required. The drills are worked in pairs, with two lines of holes drilled simultaneously, thus permitting the operator of one drill to assist the operator of the other whenever such assistance is necessary. Holes are spaced at 10-ft. intervals and are drilled in staggered rows paralleling the quarry face. The first row is back about 12 ft. from the face; the other rows are 10 ft. apart.

Blasting

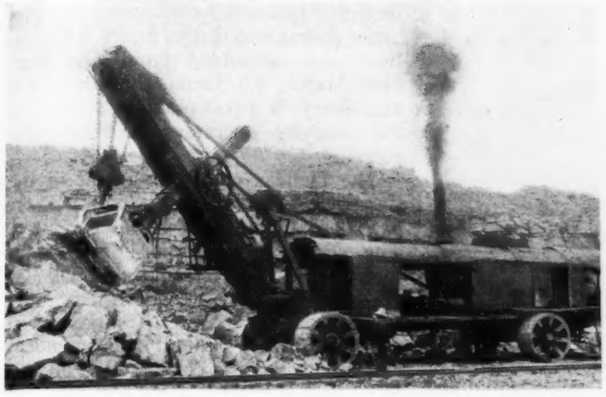
All blasting, both primary and secondary, is in charge of an expert workman who devotes all his time to it. Explosives manufactured by Canadian Industries Limited are used. The churn-drill holes are loaded with cartridges 4 in. in diameter by 8 in. long. Cordeau-Bickford fuse is employed as a detonator and all charges are fired electrically from the main transformer house. The amount of dynamite used in each hole depends upon the burden, which is carefully figured out for each hole before the shot is loaded. Where the burden is not great enough for a continuous column of explosives, which is usually the condition, the hole is "deck" loaded, two-thirds of the charge, including 20 to 25 lb. of 60 per cent nitroglycerin dynamite, being placed in the bottom and the remainder, consisting of 40 per cent ammonium nitrate dynamite, placed so that the top of the charge is not higher than 10 ft. from the top of the hole. The space between the two charges and the top 10 ft. is filled with tamping.

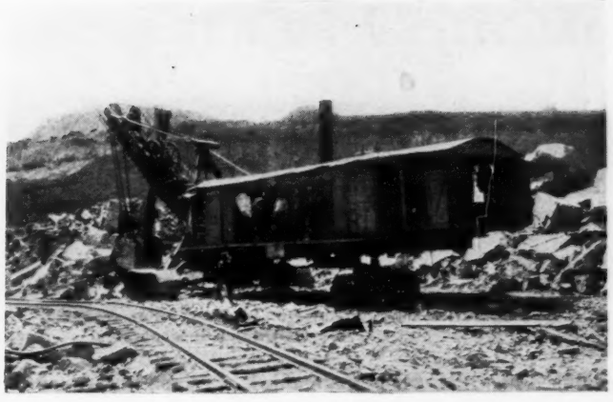
The limitations imposed on blasting do not permit blasts which are large, according to modern ideas, to be set off in this quarry, but even under the handicap of the small blasts permitted, an average of 3 tons of rock is broken per pound of explosive used, and this includes secondary blasting.

Good fragmentation is generally secured in the initial blasting, and no toes of unbroken rock are observable

Fig. 3—Pair of electric churn drills

along the face. The beds usually separate readily, owing to the presence of films of shale between them, but there are always some masses too large for handling, and these, after they are pushed aside by the power shovels, are broken up by secondary drilling and blasting, usually termed "pop-holing." This operation consists in drilling a $1\frac{1}{2}$-in. hole to the center of each large rock fragment. The holes are loaded with 60 per cent nitroglycerin dynamite and fired by a blasting cap on a slow-burning powder fuse. A Holman plug drill is usually used for this purpose. Air for the drill is supplied by two air-cooled Westinghouse compressors run by a 25-hp. Canadian Westinghouse motor. Both compressors and the motor are mounted on a truck chassis and thus can be moved about the quarry easily. This equipment de-





Figs. 4 and 5—Steam shovel on traction-wheel mounting (at left), and on crawler-truck mounting (at right)

livers 135 cu.ft. of air per minute at a pressure of 80 lb. A steam-driven air compressor of about the same capacity, mounted on a quarry-car frame, is also available for this purpose if required. Steam for this latter compressor is supplied by one of the quarry locomotives.

Care is taken in all blasting operations to maintain the quarry faces in either straight lines or in long sweeping curves, so as to facilitate the work of the steam shovels.

Loading

The rock is loaded on side-dump quarry cars by power shovels (Fig. 7). The latest shovel purchase is a 120-B Bucyrus, full-revolving electric shovel, equipped with crawler treads and a 4-yd. dipper (Fig. 6). Two large steam shovels are also in use; one is a 3-yd., Model 90 Marion mounted on crawler trucks (Fig. 5) and the other is a 3-yd., Model 103-C Bucyrus mounted on traction wheels (Fig. 4). The latter shovel is to be scrapped in the near future, as the combined loading capacity of two shovels is sufficient to supply the crushing plant with rock.

Both steam and electric shovels working on the same property provide an illustration of recent progress made in mechanizing the quarry industry. Each of the steam shovels with regular capacity of 2,500 tons of rock in ten hours requires a crew of six men—an engineer, a fireman, a craneman, a coal-passer, and two pitmen. The electric shovel, with a regular capacity of 3,000 tons in the same period, requires the services of one engineer and two pitmen.

At one time the west quarry (the original one) was worked in three levels, with a power shovel on each level, but with the working back of the face to the north the strata composing the top level was found to have been completely eroded away. This led to the opening of the east quarry and to a slackening of operations in the original quarry. The electric shovel, by operating alternately on the top and bottom levels, now handles the entire output from the west quarry.

Transportation

Stone is conveyed from the quarry faces to the crushing plant by a steam railway system. The tracks throughout are built of 60-lb. rails laid on wooden sleepers and are 36-in. gage. In the west quarry, tracks are laid on each level parallel to the face. For about the first third of the way along each level the tracks are double, but single track is used for the remainder of the distance. In the east quarry a single-track loop is laid. Spring switches are used throughout the system. The tracks are well ballasted, particularly the lead tracks, and derailments are rare. The steepest grade for loaded cars is 2.5 per cent; this grade is where the track from the bottom level of the west quarry comes up to join the track from the top level. A steel trestle is built over the edge of the escarpment to enable the rock to be dumped to the hopper of the primary crusher on the sloping face of the cliff.

Transportation equipment consists of six 20-ton, saddle-tank locomotives and 50 wooden side-dump cars lined with steel. Each car holds 4 yd. of rock. When the haulage system is electrified the 4-yd. cars are to be replaced by 8-yd. steel side-dump cars whose size is more in keeping with the dipper capacity of the electric shovel. Two trains serve each shovel. For short hauls 7-car trains are used, but for the long hauls from the far end of the west quarry (2,200 ft.) 11-car trains are made up. Each train crew consists of an engineer and brakeman. The 3-yd. steam shovels regularly load 7-car trains in 8 min., and the trains are dumped by hand in 5 min. The speed at which trains are operated allows an empty train to be waiting to move up to the shovel as soon as a loaded one pulls out.

Water for the locomotive and steam shovels has to be pumped to the property from a considerable distance, as none is available in the quarry itself. The water is stored in a reservoir on top of a little hill near the entrance to the main quarry. Standpipes are provided for the locomotives and for filling the tank cars which serve the steam shovels.

Machine Shop

All ordinary repair work on quarry machinery and much rebuilding of worn-out equipment are done in a well-

Figs. 6 and 7—Electric shovel clearing way for new track, at left, and at the right is the steam shovel loading 4-yd. side-dump cars

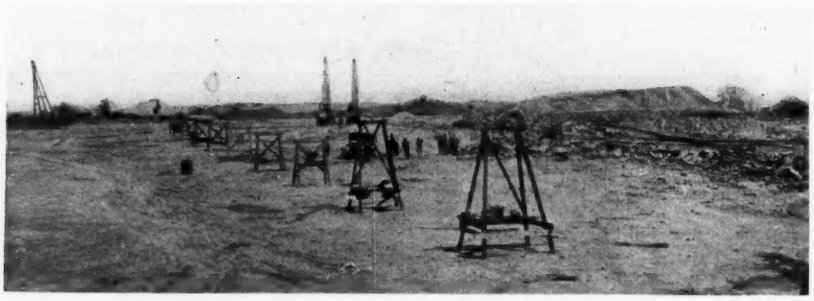


Fig. 8—Trestles carrying low-voltage power line to drills. Note shape of huge soil dump in ground

equipped machine shop maintained at the quarry. The staff of the repair department consists of a machinist, a helper, two blacksmiths, and two car repairers. The equipment includes a lathe, shaper, drill, bolt cutter, power saw, forge, and an Armstrong bit sharpener.

Electric Power Distributing System

In many phases of the quarry operations, advantage has been taken of the availability of electric energy, and, as was mentioned previously, plans for the near future entail the complete displacement of steam by electricity. The electric distribution system at present installed has been carefully designed to eliminate troubles that are the result of low voltage, with the attendant high costs incident to the maintenance of the motors.

Electric energy is delivered to the property from the distribution lines of the Ontario Hydro-Electric Commission at 13,000 volts, 3 phase, 60 cycles. This is stepped down to 2,200 volts at the main transformer house by a bank of Canadian Westinghouse transformers and delivered to the primary distribution system, which is carried on a semi-permanent pole line paralleling the face of the quarry, far enough away so that it is not likely to be damaged during blasting operations.

From the primary system energy at 2,200 volts is delivered to the electric shovel through rubber-insulated, three-conductor, portable drag cables, which are connected to the pole line through a switch stand equipped with safety switches and fuses.

For use by the motors on the churn drills and portable air compressor, the voltage on the primary line is stepped down to 220 volts. To keep the low-voltage lines as short as practicable, three banks of transformers have been placed at intervals along the primary line. The three-conductor, secondary power lines running from these field transformers to load centers are carried on movable trestles equipped with insulators (Fig. 8). Final delivery to the drill motors is made through a switch stand and drag cables provided with safety fuses. All power lines, transformers, motors, and other electrical apparatus are inspected and maintained by an electrician.

Personnel

A modern quarry operation requires but few unskilled laborers—certainly no more proportionately than does a large underground operation. The Dundas quarry is operated by 41 men when running at capacity. This figure includes superintendents and machinists but excludes the staff of the crushing plant. The quarry is usually worked on the ten-hour day basis, but the tendency is toward continuous day and night operations in the future. Operations are suspended from Christmas until March, but during this period the machinery is overhauled and most of the machine operators are thus employed.

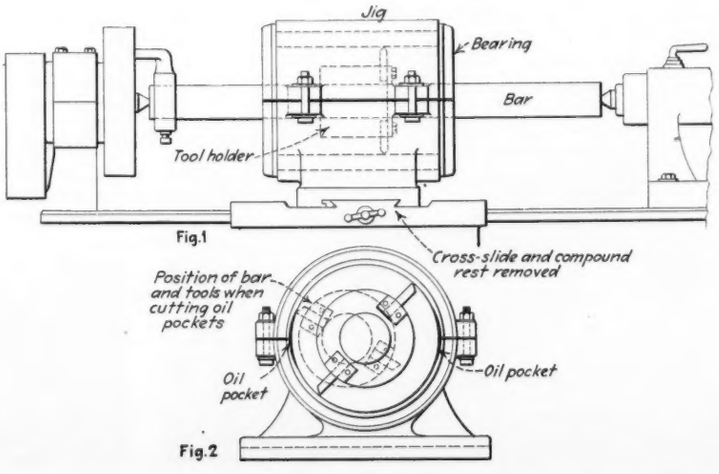
The Dundas quarry is a unit of the Canada Crushed Stone Corporation, the head office of which is in Hamilton. The officers of the corporation who direct the technical operations at Dundas are: C. M. Doolittle, president and general manager; W. H. Lindsay, manager; J. Stevins, general superintendent of quarries for the corporation; and R. W. Cunningham, superintendent at Dundas.

The writing of this article was made possible through the courtesy of Mr. Doolittle, and special acknowledgment is made to him. To Mr. Lindsay and to Mr. Cunningham I am also greatly indebted for the detailed information on the quarry operations, and to Major G. L. Drew for information on the history of the company. The large photograph here reproduced was furnished through the courtesy of the corporation.

■ ■

Turning Crankshaft Bearings on Diesel Engines

CRANKSHAFT BEARINGS on multiple-cylinder diesel engines must be turned and machined with utmost precision, to prevent vibration and costly adjustments. The procedure employed at most machine shops is the faceplate method. For large bearings, however, this is not a satisfactory method, on account of the time consumed in centering and adjusting the bearings and the commonly occurring slight differences in bearing centers. A convenient way to overcome these disadvantages, recently developed by F. R. Kennedy, master mechanic of Old Dominion Company, Globe, Ariz., is illustrated in Fig. 1 of the accompanying sketch. The lathe set-up, resembling that of a horizontal boring mill, consists of a carefully machined clamp-like fixture, housing the bearing, and a sturdy bar equipped with an adjustable tool holder. The fixture is attached to the dovetail cross-slides of the lathe apron, from which the compound rest and cross-slide have been removed, and is actuated by the cross-feed screw and handle. This permits quick and precise centering of the bearing, as well as milling-in of the oil pockets. (See Fig. 2.)



Personal Notes . . . Comment . . . Criticism

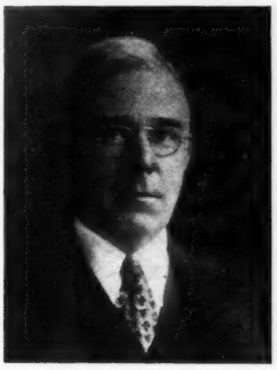
E. W. McCullough is now professor of mining engineering at the Case School of Applied Science, at Cleveland, Ohio.

C. G. Mohney, formerly chief engineer of New York & Honduras Rosario Mining, and until recently with Magma Copper, has joined the staff of the Molybdenum Company of America.

H. H. Retter, night foreman at United Verde Extension mine at Jerome, Ariz., is in the hospital suffering from a fractured hip sustained in a motor accident on the haulage level.

Dr. Noel H. Stearn, consulting geologist, of St. Louis, has been retained by the interests controlling the newly discovered quicksilver deposits in the Ouachita Mountains of Arkansas.

Richard N. Hunt has moved his residence from Santa Barbara to Los Altos, Calif. He is now on an extended trip in Mexico, whence he expects to return late in November.



WALDO H. COMINS

Waldo H. Comins, local manager for the National Lead Company, at St. François, Mo., has been appointed chairman of the mining section of the National Safety Council.

Guy C. Riddell is now consultant to the U.S.S.R. Rare Metals Trust. His address is Soyuzredmet, Moscow. Mr. Riddell inspects, by airplane trips from his Moscow headquarters, such far-apart operations as those in the Urals, the Donetz Basin, and Turkestan.

Prof. A. T. Sweet, of Houghton, Mich., notified us too late to correct an error in the item in the last issue about the award of the Alfred Noble Prize. This prize was established in 1929 by Alfred Noble, an American civil engineer, and has no connection whatsoever with the Nobel prizes.

L. A. Levensaler, formerly Northwestern representative of the mining department of American Smelting & Refining, has returned from Alaska to Seattle, Wash., where he has opened offices as a consulting engineer.

Morris J. Elsing, of Tucson, and **James B. Tenney,** of the Arizona Bureau of Mines, will be the speakers at a meeting on Nov. 20 of the "Arizona Miners' Society," a student affiliation of the A.I.M.E., at the University of Arizona. Mr. Elsing will speak on mining costs and economics, and Mr. Tenney will speak on copper and the copper tariff.

J. M. Callow, president of the General Engineering Company, and his son, **M. J. Callow,** are now in London following the completion of the construction and placing in operation of the Mount Isa smelter and other surface equipment. They expect to return to the United States late in December.

Milo W. Krejci, a member of the staff of Archer E. Wheeler, in Russia, was a recent visitor to New York. He left again for Russia on Oct. 26. Mr. Krejci has been engaged in Russia since the spring of 1930. During his stay he has traveled extensively from the Baltic to the Mongolian border, inspecting copper and lead plants.

Tom M. Owen, general manager of the Lake George Metal Corporation, at Captain's Flat, New South Wales, and formerly general superintendent of mills for Federal Mining & Smelting, at Wallace, Idaho, is at present engaged as consultant on flotation at Wiluna, Western Australia.

Philip D. Wilson, of American Metal, calls attention to an error in the article on rubber pipe lining in the Oct. 26 issue of E. & M. J. In the table on page 367, water added to sand fill was given as 0.40 g.p.m. This should have read 40 g.p.m.

Louis S. Cates, president of the Phelps Dodge Corporation, in a statement read at a recent meeting of the Arizona Tariff Commission, in Phoenix, said that he is strongly in favor of a tariff on copper.

Oliver Hall, for many years in charge of mining operations of the Mond Nickel Company, and for the last two years general superintendent of mining for the International Nickel Company of Canada, has been appointed assistant general manager of Noranda Mines. **Ralph D. Parker,** manager of the Frood mine, of International Nickel, has been appointed general superintendent of mines, succeeding Mr. Hall, and **H. J. Mutz** has been promoted to the post of superintendent of the Frood mine.

Robert E. Tally, president of the American Institute of Mining and Metallurgical Engineers, gave an address at the recent annual dinner of the Washington section. In the course of his remarks he expressed an opinion that mining engineers will do best for themselves and best for their industry if they devote an increasing amount of their time to the economics of mining. He commended to the consideration of all mining engineers the example set by Dr. Bain, who is leaving the Institute to devote his time to an effort to find new uses for mineral products and to work toward an efficiency in distribution comparable to that which has been obtained in production. Mr. Tally expressed the opinion that business, as a whole, would be opposed to a repeal of the anti-trust statutes. He said that they are a great protection to everyone in business, in that they preclude practices which otherwise would be forced upon many by the pressure of competition. He urged very strongly, however, the amendment of the anti-trust laws so as to permit cooperation in matters which would make for employment and general permanence.

Among contributors to this issue:

C. N. Schuette, a consulting engineer of San Francisco, Calif., is a graduate of the University of California and an authority of the metallurgy of quicksilver ores. He was co-author, with Dr. L. H. Duschak, of "The Metallurgy of Quicksilver," published in 1925 by the U. S. Bureau of Mines, and of several other publications.

J. D. Pollett, an associate of the Royal School of Mines, London, is a member of the staff of the Geological Survey of Sierra Leone, with headquarters at Freetown, East Africa.

M. F. Goudge is a graduate of King's College, Nova Scotia, and of the Nova Scotia Technical College. He has been associated with the Mines Branch of the Department of Mines of Canada, specializing in limestone and its products, since 1923.

L. F. de Moraes Rego, after graduation from the Escola de minas de Ouro Preto, was associated with the Companhia Minas e Viaçáo de Matto Grosso, operating manganese mines at Urucum. In 1919 he joined the Serviço Geologico e Mineralogico de Brasil as assistant chemist. In 1921 he was transferred to the geological department, being appointed geologist in 1923, a position he now holds.

L. Reid (University of Nebraska) is mechanical engineer on the staff of the Diamond Crystal Salt Company, Lyons, Kan.

Concentration of Iron Ore by Flotation

To the Editor:

An interesting article, "Flotation of Hematite a Laboratory Success," by A. S. Adams, S. M. Kobey, and M. J. Sayers, appears on page 54 of the July 27 issue. The authors state in the introduction: "Concentration of iron ore by flotation has not, to our knowledge, been accomplished commercially, though some preliminary work has been done. . . ."

This remark necessitates my directing attention to the fact that flotation of iron ores on a commercial scale has been in effect in Germany for several years.

In my book "Flotation," published with H. Schranz (S. Hirzel, Leipzig, 1931), you will find on pp. 399-402 references to the flotation of iron ores. One reference discusses operations at the Grosse Burg mine of the Vereinigten Stahlwerke A.G., Neunkirchen. This installation, described in an article by H. Miessner that appeared in 1928 on p. 248 of *Metall und Erz,* employs selective separation of spathic iron ore and copper pyrites. A more recent description of the plant is presented in the aforementioned book.

A second installation, in operation for years, is at the Mineralia A.G. für Erzbergbau, in Fichtelberg. Here hematite, which for the most part occurs as specular iron ore in a crystalline, laminated form, is selectively separated from pyrite. Operations have recently been suspended at this plant, owing to the liquidation of the company. It is described on pp. 400-402 of my book.

Berlin, Germany. E. MAYER.

Extension of the Flotation Process into New Fields

To the Editor:

The flotation process finds its greatest application in the concentration of minerals having a natural metallic lustre, such as the sulphides, but relatively recent studies have shown that it can also be applied to the concentration of non-metallic minerals, such as bauxite, fluorspar, feldspar, garnet, phosphatic materials, and quartz. The application of flotation methods to the concentration of coal dust and graphite is also now well established.

Numerous suggestions have been made of the possible valuable application of flotation methods to other industrial uses. For instance, the light waste material from sugar cane can be separated from the heavier good bits of cane in waste waters by froth flotation; rosin may be separated and recovered from rosin-bearing coals; paper and other pulp fiber from backwaters or waste solutions; thistle buds, leaves, and stems, from peas; and hair may be recovered in tanneries by the froth flotation process. Froth flotation may be used, also, in the separation of some chemicals from each other, such as anthracene from naphthalene, and carbazole from alizerin; for the recovery of liquid suspensions from a liquid, as wool oil and fat from wool washings; and for the recovery of gold filings or metals from waste waters, as from jewelers' wash water. Flotation can be used, furthermore, to recover edible organic waste in starch and cereal factories. Here, an edible oil is used for the flotation reagent. Flotation methods can be used in certain processes of sewage disposal; as a means of sizing paper pulp fibers; and for purifying soluble substances from their insoluble constituents—for example, crude caliche is dissolved and the insoluble materials are separated from the solution by flotation.

These varied applications of the flotation process, aside from being of interest, may suggest new applications for the art.

MAHLIN S. HANSEN.

Indianapolis, Ind.

Origin of Chilean Nitrate

To the Editor:

The article by Mr. Bjarne Hofseth on "The Origin of Chilean Nitrate" should reawaken interest in a controversial subject. This latest theory, adding to the already large number, at least serves to demonstrate the need for a detailed field study of the nitrate country between the cordilleras and the sea. Those interested in this subject will find a complete summary of earlier theories in F. W. Clarke's "Data of Geochemistry."

Unfortunately, no analyses are available of the gases of Chilean volcanoes. Volcanic vents, hot springs, and fumaroles yield boric acid and ammonium salts, and the deposition of calcium borate has already been noted in the case of Chilean hot springs. A near volcanic source need not be assumed as essential, providing other conditions—such as wind, rains, fogs, and dew—are favorable. In arid regions dew fall plays a bigger part than is generally realized. The Director of the Geological Survey of Egypt records a dew fall of one liter per square meter at Gebel Niqrub, which is in a hot desert area 80 km. from the sea. Heavy dews, and light, drizzly night rains, have been reported by several reliable geologists and travelers in other desert regions.

An acquaintance with hot desert areas prompts the suggestion that the rapid evaporation of superficial ground waters in the Chilean pampa gave rise to a gradual accumulation of saline residues. This seems more feasible than Mr. Hofseths' theory, which is interesting but not convincing. The detailed figures given serve to diminish its value; for, obviously, in the absence of data pertaining to the region under discussion, such figures can have no significance. He ignores the presence of the sulphates, borates and chlorides found in appreciable quantities in the caliche. I suggest a more likely origin of Chilean nitrate:

Ammonium and nitrogenous gases evolved from volcanic vents and fumaroles were converted to nitric acid, which attacked the local soda-bearing igneous rocks, yielding thin layers of saline residues after light precipitation of water. Over several thousand years this would give rise to a bed of sodium nitrate of varying purity. It would also account for the borates and feldspars in caliche and costra.

A study of the volcanic features of the Andes may yet prove the key to the origin of Chilean nitrate, and this work is long overdue. J. C. DAVEY.

Sunegi Besi, Selangor, F.M.S.

■

Obituary

Henry Charles Hoffman ,president and manager of the Emerald Mining Company, died on Oct. 23 in Salt Lake City at the age of 66 years.

James S. Chester Wells, mining engineer, died at his home in Beacon, N. Y., on Oct. 29, after a short illness, in his 56th year. He was a graduate of the Columbia School of Mines, and fought with the Canadian army in the World War.

Samuel Mather, founder of the firm of Pickands, Mather & Company, died in Cleveland on Oct. 18. Mr. Mather, who was 80 years of age, was a director of United States Steel and several other large corporations in addition to heading his own firm.

J. J. Gerster, a pioneer of the Gold Hill camp in Utah, died recently in Los Angeles, Calif. He was 78 years old. Mr. Gerster owned and developed several Utah properties, one of which he sold to United States Smelting, Refining & Mining.

Charles J. MacLaren, mining engineer, died recently at his home in Pasadena, Calif. He was 76 years old, and had been in ill health for about a year. He was born in St. Louis, educated at Washington University, and engaged in engineering in Western mining districts for many years.

William Pickett, retired mining engineer and pioneer, died at his home in San Francisco on Oct. 19. He was 83 years old, and made the trip across the plains to California in 1852. He prospected and was instrumental in developing several mines in the Southwest. Mr. Pickett is survived by his widow.

Stanley C. Bagg, editor of the *Tombstone Prospector* in early mining days, and founder of the *Tombstone Epitaph,* died at his home in Santa Barbara, Calif., on Oct. 1. In addition to his journalistic activities, Mr. Bagg was interested in mining in the early days in Arizona, and discovered the property that later became the Katherine gold mine.

A. J. Pickrell, banker and mining man, died in Los Angeles on Oct. 19. He was a director of United Verde Extension and director and president of several smaller mining companies. He was 71 years old, and went to Arizona from his birthplace in Ohio in 1894. Major Pickrell resigned from active mine management and went to California in 1912, but maintained his positions as company official.

New Publications

DIE FLOTATION. *By Dr. Ing. W. Luyken and Dr. Ing. E. Bierbrauer. Berlin: Verlag von Julius Springer. Pp. 284, illus.; Rm. 29.*

THE book covers a rather wide field in the limited space of less than 300 pages. In addition to a chapter on the theory of the flotation process and flotation testing, and to a discussion of the various ores that are being treated by flotation, it gives a review of the auxiliary machines used in flotation plants, such as crushers, mills, screening and classifying devices, settling tanks, and filters. On the other hand, it does not discuss ore-dressing apparatus other than flotation machines, like jigs and tables, which still largely supplement flotation. Apparently, the authors anticipate a period in which these machines will have disappeared from flotation plants.

The theory of the process is covered in 60 pages. Although it hardly seems credible that this can be done, the authors apparently have succeeded in giving the young flotation engineer the essence of the researches of Langmuir, Perkins, Taggart, Gaudin, and others, and thereby a basis for an understanding of the process. Naturally, the historical development that forms so essential a part of other works on flotation could not be discussed, and the treatment had to be essentially didactic.

References to American literature and American engineers predominate, as seems natural, because so large a part of the development has taken place in the United States. Due attention is, however, called to the theoretical work of the early British investigators. The references to the flotation agents being produced by the German Dye Trust (Interessen Gemeinschaft Farbwerke) will be of interest. Inasmuch as they have been so eminently successful in the study of "chromophore" groups in chemical compounds, it is natural to expect that they might also succeed in building up some of the so-called polar-nonpolar compounds that seem to be instrumental in effecting the attachment of air bubbles to mineral surfaces.

The following statements in which the authors define the scope and the prospects of the flotation process seem significant: "The flotation process is an ore-dressing procedure in which the mechanical separation of various minerals is accomplished on the basis of their chemical properties." And: "It must be possible to attach nonpolar groups to any kind of a mineral surface, thereby producing a hydrophobic surface either by applying a polar-nonpolar reagent directly or after providing an intermediate adsorption layer."

Similar opinions have been voiced by other investigators of the flotation process, and every flotation engineer will adopt them as an aim to be striven for. At the same time, the development of leaching plants—at Inspiration, Ajo, and Portrerillos, for instance—demonstrates that up to the present time we have not been able to accomplish this aim so far as oxidized copper minerals are concerned.

RUDOLF GAHL.

■ ■

APPLIED GEOPHYSICS. *By Capt. H. Shaw, J. McG. Bruckshaw, and S. T. Newing, Pp. 101; illus. London, England: H. M. Stationery Office, Price 2s.*

THE Science Museum at South Kensington has succeeded in collecting a fascinating series of exhibits covering various geophysical methods of exploration. No small part of its interest is due to the fact that a successful effort has been made to represent the historical side of the subject. Most of us have read about Gilbert's Terrella, the old Swedish mining compasses, and Kater's pendulums for measuring gravity, but actually to see the originals on exhibition must have been a rare treat for those who had the opportunity to visit the Kensington Museum. Lest the visitor be lost in the unaccustomed intricacies of applied geophysics, Captain Shaw and his associates prepared this booklet to serve as more than guide.

A readable introduction to the subject discusses, in a few pages, the scope of the four main methods, gravitational, magnetic, seismic, and electrical, and describes in simple language the principles upon which they operate. Each one is then taken up in a separate section, which goes into some detail concerning its history. By describing briefly the types of recent successes attained, these sections are brought down to date. Although the book is designed primarily for the layman, the geophysicist will find the historical treatment of interest, for material is included which has seldom found its way into print, at least not in collected, sequential form.

It is unfortunate that the authors' unfamiliarity with electrical methods led them into such erroneous statements as that on p. 45, where they imply that Wenner's system required the placing of four electrodes in a straight line at equal intervals. As a matter of fact, Wenner also developed his formula for the general case of four electrodes irregularly placed. They also state that the direct application of Wenner's principles would lead to erroneous results because of spontaneous polarization and natural earth currents, whereas Wenner specifically adopted an alternating current technique in order to avoid just such difficulties. Nor do the authors seem to be aware that Schlumberger no longer uses non-polarizing electrodes in his resistivity determinations. Exception must also be taken to the statements on p. 49 that flat-lying deposits can be detected by the equipotential method, and on p. 40 that certain carbonates can be detected by spontaneous polarization measurements. Although they mention on p. 48 that Conklin was a pioneer in electro-magnetic methods, the authors omit to say that to him belongs the honor of taking out basic patents on the horizontal loop technique in 1917.

The second half of the book is taken up with a catalog of the exhibits at the museum. This is more than a mere listing, as there is a sufficiently adequate description of each piece of apparatus and each diagram to repay well the reading of this section, even though the exhibits are not visible, except for an occasional illustration.

PRINCIPLES AND PRACTICE OF GEOPHYSICAL PROSPECTING. *Report of Imperial Geophysical Experimental Survey. Edited by A. B. Broughton Edge and T. H. Laby; pp. 380; illus. Cambridge, England: University Press; 15s.; New York: The Macmillan Company; $5.*

ETUDE SUR LA PROSPECTION ELECTRIQUE DU SOUS-SOL. *By C. Schlumberger; Second edition; pp. 100; illus. Paris: Gauthier-Villars.*

BOOKS like these are needed. Most of what has appeared in English on geophysical exploration has been written by authors with "an axe to grind," and devoted to extolling the virtues of one system or another. In undertaking this survey, the British Empire Marketing Board and the Australian Government were interested in testing various geophysical methods in Australia, under field conditions that might be considered characteristic of large portions of the Empire. For two years the work progressed under the direction of Broughton Edge, testing electrical, magnetic, gravitational, and seismic methods of prospecting, under a wide variety of conditions. Although the intention of the field parties was not to search for undiscovered orebodies, some were found.

More than one method was frequently employed on a given problem, thereby emphasizing the utility of having several angles of approach when undertaking geophysical investigations. All four methods were used, for example, on the Gulgong deep-lead gold deposits. The Gelliondale brown-coal deposits were studied by gravimetric and

magnetic techniques, and electrical and magnetic methods were employed over the stanniferous pyrrhotite deposits of Renison Bell. The number of areas examined electrically exceeded those studied by other methods, because the mining fields of Australia seemed to offer greater opportunity for electrical investigations, and because of the speed with which this type of work could be carried out. Instrumental troubles slowed down the gravimetric parties, and the seismic work was not instituted until late in the program. Magnetic methods were looked on, in the main, as subsidiary to the gravimetric and electrical methods, although in some instances they assumed priority over the others.

In spite of extensive literature on electrical methods of prospecting, little frankness has been shown in setting forth the theoretical bases upon which the methods depended, or in explaining the instrumental technique. Thus handicapped, the Imperial Survey spent considerable effort to fill this gap before it undertook field work. The results provide, at last, details of electrical theory and technique. For this alone, the report is to be commended.

In order not to confuse with highly theoretical discussions the reader who is searching for practical results, the book is divided into two parts. The first deals with field surveys, with only enough theory to enable one to follow the field technique. In the second part are four chapters devoted to each of the four methods, explaining and discussing the theoretical fundamentals, describing the instruments used and the principles of their operation. Half of this section is devoted to the electrical techniques. The report is attractively bound and well illustrated. It is a beautiful example of the typographer's art; on many counts a valuable addition to a geophysicist's library.

Mr. Schlumberger's treatise, "Study of Sub-Soil Electrical Prospecting," is a re-issue, with little modification, of the treatise by the same name published in 1920. The only change introduced is the correction of a misapprehension in the first edition, concerning the relationship of equipotential curves to tilted strata, and the addition of a second preface. A typographical error in a formula on p. 23 of the old edition remains uncorrected in this one, on p. 25.

With the great progress made by the author and his associates along the line of resistivity studies, one regrets that he has not seen fit to incorporate some of the results of his rich experience in a greatly augmented edition of his classic treatise. This present work deals with the fundamental concepts used in developing the theory and practice of electrical prospecting by equipotential methods, and is to be recommended to any one desiring to make a serious study of electrical exploration. Evidently, much of this material applies also to resistivity studies, and these are discussed in many ways. The more complete elaboration of this field would be of value in Mr. Schlumberger's book. SHERWIN F. KELLY.

■ ■

MODERN DIESEL ENGINE PRACTICE. *By Orville Adams. Pp. 656: illus. 1931. New York: Norman W. Henley Publishing Company. Price $6.*

THE quantity of information presented in this book indicates a wide experience by the author, who has included many interesting tables, charts, and illustrations. In general arrangement the material could be improved and condensed, as there are many duplications. This is particularly true in the earlier chapters.

A short historical discussion is followed by information on the selection and costs of various types of plants, maintenance figures, specifications, auxiliary equipment, and types of drive. Stationary and portable applications are covered with specific data relative to operating costs of typical plants.

A chapter ranging from definitions adopted by the Diesel Engine Manufacturers' Association, through fuel injection methods and piston cooling, is followed by two chapters covering operating data on specific engines. The first of these is the four-cycle, solid-injection type, while the second is four-cycle and air-injection. This material has evidently been taken from manufacturers' publications, and the descriptions and operating instructions are good.

The real gist of the book from an installation and operating standpoint is found in chapters nine to twelve inclusive, which cover many important points often overlooked by one unfamiliar with diesel equipment. Foundations, buildings, plant arrangement, water, fuel, lubricating oil, air and exhaust systems, and other items in connection with the proper engineering of the diesel plant are well covered.

In the next two chapters the material is rather poorly balanced, as is indicated by the fact that a total of 26 pages is devoted to a certain patented type of piston ring. A chapter on Repairs and Maintenance indicates some of the troubles which result from improper care and some of the up-to-date methods used in making difficult repairs. The author emphasizes the importance of daily operating records and shows several typical forms suitable for use.

The last six chapters might well form a separate volume, as they deal with special applications of the diesel to the aircraft, locomotive, and smaller automotive fields, and go into considerable detail regarding the construction and operation of engines for this service.

The author has provided a very complete index, which is indispensable in a book of this kind if it is to be of real reference value. This index counteracts, to a large extent, the somewhat scrambled arrangement of the text, which would be unnoticed if it were used solely as a reference work. In general, the book contains a wealth of good material, but might have been condensed considerably with no great sacrifice of its value, even though its impressive thickness would have suffered. T. M. ROBIE.

■ ■

A SELECTED LIST OF BOOKS AND REFERENCES ON GEOPHYSICAL PROSPECTING. *By C. A. Heiland and Dart Wantland. Colorado School of Mines Quarterly, Vol. XXVI, No. 3. Price 50c.*

The title of this 24-page pamphlet explains its character. The list, say the compilers, has been prepared primarily for students who wish to obtain a fairly detailed yet broad knowledge of all phases of geophysical prospecting, and who find textbooks on the subject comparatively few in number. In connection with this list may be mentioned also No. 1 Supplement A to Vol. 26 of the *Quarterly*, which contains an article by Dr. Heiland describing the Department of Geophysics at the Colorado School of Mines. Courses and equipment are covered in detail, with ample illustrations.

■ ■

ERZMIKROSKOPISCHE BESTIMMUNGSTAFELN. *By H. Schneiderhönn and P. Ramdohr. Pp. 47. Berlin: Geo. Borntraeger, Schöneberger Ufer 12 a; 3.80 RM.*

A valuable appendix to the textbook on ore microscopy which was reviewed in a recent issue of this publication. It is composed entirely of tables giving physical constants needed in the microscopic determination of minerals.

■ ■

QUICKSILVER. *By C. N. Schuette. Washington, D. C. U. S. Bureau of Mines Bulletin 335. Pp. 168. Price 45c.*

Material for this report has been gathered during recent visits to the quicksilver-producing districts in the Western states. The book is divided into the following chapters: Prospecting, Development, and Mining of Quicksilver Ores; and Economics of Quicksilver.

INDUSTRIAL PROGRESS

Proper Maintenance of Blast-Hole Drills Insures Longer Life

J. Reynard
Loomis Machine Company, Tiffin, Ohio

IF THE user of blast-hole drills desires to get years of service and life out of his machines with few repairs, certain precautions regarding upkeep and the method used in drilling must be taken, because no piece of machinery used in the field is subject to more abuse than a drill of this type. Often the fault is due not to lack of attention but to lack of knowing just what to do to keep the machine operating properly.

When a machine with a wooden frame is being started up, all parts must be put in place and all bolts made tight, but not so tight as to sink the washers into the wood. These bolts will become loose, because of shrinking of the timber and weather conditions, and they must be kept tight and looked after continuously, week in and week out, whenever the machine is running; otherwise its life will be materially shortened.

When steel frames are furnished, lock washers are part of the equipment, but after the machine has been in operation a few hours they should be inspected to see that nothing has loosened. The tendency for the bolts to loosen on the steel frames will be less than on frames of wood.

On first starting a machine, it should be allowed to run idle for two or three hours before putting a load on it. Bearings should be watched to see that none are heating, in the meantime having been oiled carefully. If any bearing shows heating, the box should be loosened slightly until the bearing gets set. After the load is on the machine, the entire outfit should be gone over several times during the first few days to see that everything is running cool and in good condition, and that lubrication has reached all parts.

Upkeep of cables, tools, and accessories is part of the upkeep of the machine. When manila cable or rope is being put on, it must go on the rope spool straight and tight, for if put on loose, the rope when raising the tools and starting to drill will pull in between the under coils, cause a strain, and set up friction which will burn the rope. This often results in the cable breaking and being condemned as poor, although it may be as good a piece as ever was sold. In such circumstances the drill manufacturer is usually blamed for the poor quality of the rope.

By running two rounds of old rope on the reel drum and pulling them tight by the machine, a cushion is made which will improve the life of the rope. This can be tightened by putting a piece of wood across the wheels and letting the rope slip on it as though it were a drum. This will serve to tighten the cable on the reeling drum. The coils must be driven together so that there will not be enough space between wrappings to allow the main cable to pull in between them. After this has been done, one strand of rope unbraided from an old used cable should be laid in the crease between the coils. This gives a large coil and a fine cushion and will increase the wear of the cable materially. The drilling rope should never be allowed to run on top of itself, but should be kept on this cushion. The rope should be kept wet at this point. Cable can sometimes be made to last two or three times as long by thus taking proper care of it, and will yield just as much drilling per hour.

Tools and joints should be cleaned with kerosene to remove any oil. A small smooth sandstone can be used to remove rust and dirt. They should then be washed in clear water and the tool joints set up with wrench bar and chains, such as used by most blast hole drillers. They should be set snug, but not as tight as two men can pull them. A small mark across the shoulders where they come together will show whether they are loosening any. After they have been drilled for a while they will settle and can be tightened a little more than they were at first.

On starting to drill, the tools must be raised 2 or 3 in. from the bottom of the hole and kept at that distance as they are fed out and the hole becomes deeper. They should never be allowed to sit on the bottom when they are not in motion, for this will take the stretch out of the rope. When the motion is thrown in, the cable will then be too slack.

When wire drilling line is used, the same advice applies. Closer supervision is required, for if too much slack is allowed, the line will soon break at the top of the rope socket and if the tools are not fed out correspondingly as the hole deepens, the backlash or pound will come on the machine, shortening its life materially.

In "wire-line" drilling, shock-absorbing devices are furnished for the machine. As already stated, wire line requires closer attention than manila when drilling, because it is stiff and stretches less and must be fed out gradually. It cannot be fed out 4 to 6 in. and then be allowed to "drill out," as with manila line, but must be fed gradually as the hole deepens. Wire line is being adopted by many operators who are using more than one machine, and it is proving successful, not because of any great advantage in footage but because of the reduced cost of rope as compared with manila. It should be kept well oiled on the rope drum. Thus it will lubricate the pulleys as it passes over them.

Some remarkable records have been made in the total number of feet drilled with one wire line. Usually a man who has been running manila rope does not like to drill with wire line, especially at first. He must learn to use it properly and give it constant supervision.

Wire line runs best with a swivel rope socket. When it is fastened solid in the rope socket instead, and the tools spin around at times so as to twist or untwist the rope, the line will shorten or lengthen as it twists or untwists. This makes for unsatisfactory operation because it changes the "hit" of the tools; hence the swivel socket is recommended in wire line work.

Speed of the tools is controlled by the length of the stroke. It will vary from 45 to 60 strokes, depending upon the length of the stroke and the hole in the crank in which the pin is set. Tools can be run too fast to make the most hole or they can be run too slow. They can be run on too tight or too loose a line. They should not be run any faster than is sufficient to take up the slack caused by the machine, because they must be given time to strike the bottom before they start to pick up. The machine must be timed to pick them up at the top of the rebound and carry them on up.

The same speed cannot be maintained all the time. Speed is governed by the depth and kind of hole, whether it is straight, crooked, or not quite round—whether there is much water or sludge in the hole. These factors will cause

the fall of the tools to vary, which is one of the reasons why variable speeds should be part of drilling machine equipment. The machine can then be properly adjusted to the speed of drop of the tools.

As the hole deepens, manila cable stretches more in proportion than wire line, so that the stroke of the blow at the bottom of the hole lengthens and fewer blows per minute will have to be given, because a longer time is required for steel to drop a long distance than a short distance. The result in general will be fewer blows for longer stroke, more blows for shorter stroke.

A worth-while bit of advice is to stop long enough from time to time to keep the machine in constant repair. Nothing is so costly as neglect of repairing when needed. When the repair is first required, it may be small and amount to little, but in time it multiplies and induces other detrimental features. Delay ultimately means a larger repair bill and accumulation of troubles.

A drill should be kept well painted, whether it is of wood or steel. Many machines which have been in operation over ten years are in better running condition than some which have been run only twelve months. Some of the machines that have been run ten years have the cheapest drilling cost. We know of one company which has been operating a number of machines over a long period of years at approximately 14c. per foot in hard, heavy limestone. This includes everything—power, help, and all upkeep with the machines.

Some drillers say that they do not see the management around their machines for weeks and sometimes months at a time. For this reason the driller often has to maintain his equipment himself.

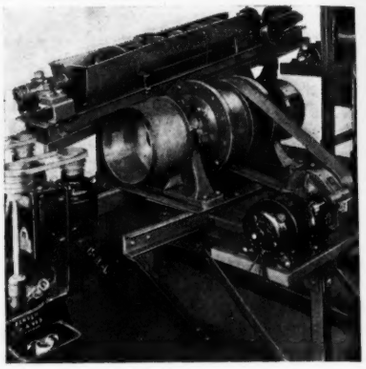
Not long ago I saw a steam-power machine working and heard the cylinder rings scratching when I was a distance away. This was for lack of oil. The attendants had removed the oiler from the engine. I watched them for a time before anybody knew who I was and told them they were running their engine without proper lubrication. The drillers condemned the engine, saying that it would last as long as the other parts of the machine; whereas, the fault lay merely in lack of lubrication and ordinary care.

At another place, where five machines were operating, all of the drillers were in a shanty, pitching coins to see which had to get out and let out the ropes on the machines to feed out the tools. It is obvious that on machines where the tools are not properly fed out the machine will rack itself to pieces.

A little care, adjustment, tightening, and looking after a drill, with proper operation, will save much expense, and assure long life and an enormous amount of drill hole over a long period of years.

Standard Specifications for Sieves for Testing Purposes

Initiation of a project to develop standard specifications for sieves for testing purposes has been approved by the Standards Council of the American Standards Association. The American Society for Testing Materials and the U. S. Bureau of Standards have been appointed joint sponsors for the work. Organization of a committee which will include American technologists interested in sieves for the purposes stated is under way. This committee, it is expected, will work with the International Standards Association's Technical Committee on sieves for testing purposes, with the idea of possible development of an international standard.



Grinding mill and classifier of redesigned continuous flotation testing unit

Two New Excavators of Small Size

A new excavator, convertible as desired to shovel, crane, trench hoe, or dragline, has been introduced by the Link-Belt Company, Chicago. It is known as the Model K-48, and is arranged for drive by either gasoline engine, diesel engine, or electric motor. The gasoline engine is rated at 130 hp. and the other drives correspond. Equipped as a shovel, it has a 1¾-cu.yd. dipper. As a crane it has a rated capacity of 32 tons at 12-ft. radius and 5.2 tons at 45 ft. radius on a 45-ft. boom. As a dragline, it will handle a 1¾-cu.yd. heavy bucket on a 45-ft. boom and will do proportionate work on a 50-ft. boom.

Another new excavator is the Type 120 Marion convertible machine of ½ cu.yd. capacity. This may be had equipped as shovel, dragline, clamshell, or crane. Features of design include the use of a rotating gear as large as the over-all width of the crawlers, centralized machinery mounting, ball-bearing roller path, and high ground clearance plus compactness.

Feeds Crushed Materials

Efficiency in handling all fine materials, such as sand, ground clay and shale, as well as gravel and crushed rock, and coal, up to 3 in. cubes in size, is claimed for a new disk feeder, known as the "Concenco," developed by the Deister Concentrator Company, Fort Wayne, Ind. This disk is a renewable steel circle, 60 in. in diameter, made of heavy steel plate bolted to a cast-iron spider. The spider is keyed to a heavy vertical shaft. Driving is done by worm or bevel gears. Discharge is controlled readily by varying the angle of the adjustable plow.

Flotation Test Plant Re-designed

Complete re-design of its continuous flotation testing unit No. 5 has been announced by the Denver Equipment Company, Denver, Colo. The machine is of all-metal construction, the units being mounted on a bolted steel framework. Individual motor V-belt drives are used. The unit will handle 50 to 200 lb. of feed per hour with a power consumption of 3½ hp. It is 6 ft. high and 8 ft. square. Part of it, including the grinding mill and classifier, is shown in one of the accompanying illustrations.

Cement Research Planned

Foundation of an industrial fellowship by the Green Bag Cement Company of Pittsburgh, subsidiary of the Davison Coke & Iron Company, has been announced by Dr. Edward R. Weidlein, the director of the Mellon Institute of Industrial Research, Pittsburgh, Pa.

The investigational work, to be carried on by Raymond C. Briant, will be concerned with studies of the chemical and physical properties of portland cement and with the development of certain new cement products. Mr. Briant was formerly with the U. S. Bureau of Standards, where he has been engaged for several years in research under the auspices of the Portland Cement Association.

Progress in Abrasive Research by Producing

The technical committee of the Producers of Electric Furnace Abrasives has just completed a research program at the U. S. Bureau of Standards extending over many months, on the subject of calibrating testing screens, and has prepared and distributed to each member standard grit sizes for use in the calibration method, which have also been adopted as a result of this research work. The work was carried on by V. de Sveschnikoff, research associate selected by the Director of the Bureau, and the expenses were borne by the committee, of which the membership is made up of the following firms manu-

facturing electric furnace abrasives: Abrasive Company, American Abrasive Company, American Emery Wheel Works, The Carborundum Company, Exolon Company, Federal Abrasives Company, General Abrasive Company, and the Norton Company. The usual certified screens of the bureau were found to be too inaccurate for testing abrasives, and master screens of closer tolerances were selected and deposited at the bureau to assist in future selection of test screens for the manufacturers and users of loose abrasives.

New Coal-Pulverizing Equipment

Burning of cement clinker, copper smelting, and firing of steam boilers are included in the range of applications of coal-pulverizing equipment designed or under development by the Grindle Fuel Equipment Company, subsidiary of the Whiting Corporation, Harvey, Ill. The scope of the company's pulverized coal division has been widened to permit this. Extensive research and experimental work are under way. C. F. Herington, who has been selling pulverized coal systems for the last fifteen years, has been retained as engineer.

Electric Locomotive Equipped With Anti-Friction Bearings

Heretofore electric locomotives have been equipped with plain bearings. The Pennsylvania Railroad, however, after using Timken bearings in various types of rolling stock, has specified them for the bearings of 150 of the new electric locomotives to be built for the road for its electrification project between New York and Washington. This instance recalls the fact that about two years ago the Timken company built one of the highest-grade steam locomotives in the world, equipped throughout with its anti-friction bearings, including the main journals. This was the first locomotive ever to be so equipped. It is now said to have been tested for a year and a half on eleven railroads, to have gone over 75,000 miles, and to have been handled by more than 500 different train crews, with excellent results. The bearings are said to be as perfect as when they were put on.

Advantages of Feeders

Use of power shovel and large primary breakers has brought about the need for a feeder that will handle large rock fragments weighing as much as 4 to 5 tons, according to the American Manganese Steel Company, Chicago Heights, Ill. The practice of dumping a car of 40 tons' or more capacity onto a crusher is a source of delay if the train must wait until the crusher clears itself. Moreover, a hazard that the crusher opening will be blocked often exists. A feeder enables a train to dump into a bin and return with minimum loss of time. It can be run so that the crusher is working on an even feed at full capacity. As with any machine, a steady feed will permit more efficient operation than with intermittent feeds. A fragment that is too large can be easily seen and the feeder stopped to remove it. The company mentioned has several installations working successfully in severe service of this sort. One of these is an 8x72-ft. feeder set at 18 deg. and handling 900 tons per hour, or about 8,000 per day. Material handled is mined by shovels with 4-yd. dippers and contains many pieces weighing 1 to 5 tons. The feeder shows no appreciable wear and has called for neither repairs nor attention except lubrication of the shafting. Power consumption per ton is 0.03 kw.-hr. and the power meter shows a uniform input of 30 kw. The bin discharges through a plain throat of ample size without jamming. These feeders are made to fit all conditions from 2 to 8½ ft. in width. They have a smooth apron surface, with floor and side flange overlap to prevent fouling, leaking, and spilling. The chains have one-piece links, liberal pin surface, and knee-type joints which prevent sagging between supports.

For the Laboratory

A laboratory scale, designed to permit close reading without the use of extended beam equipment, has been developed by the Toledo Scale Company, Toledo, Ohio. Readings can be made up to 500 grams, each gram being marked on the scale. The latter also show avoirdupois equivalents. Additional capacity up to 5 kg. may be had by using weights. The design is such as to eliminate oscillation. The scale may be had equipped with either pan, platter, or scoop, as desired.

■

Industrial Notes

International - Stacey Corporation, Columbus, Ohio, has purchased the Stacey Manufacturing Company, Cincinnati. The latter is one of the oldest and largest manufacturers of high pressure tankage.

General Electric Company has opened a school of welding design at Schenectady to teach engineers, architects, and draftsmen, both in and out of its employ, methods of designing welded buildings. The course is four weeks long and free.

A new safety trophy to be competed for by members of the National Crushed Stone Association is being provided by the *Explosives Engineer* magazine. It will go to the quarry which leads the members of the Association in the annual National Safety Competition conducted by the Bureau of Mines.

Jeffrey Manufacturing Company's ventilation department is located at Columbus, Ohio, and not at Canton, as erroneously stated on page 375 of the Oct. 26 issue, in discussing the company's new Aerovane fan.

Bulletins

Crusher — Traylor Engineering & Manufacturing Co., Allentown, Pa. Bulletin 1110, superseding Bulletin 110, which was devoted to the company's Type TZ reduction crusher.

Pumps—Worthington Pump and Machinery Corporation, Harrison, N. J. Specification Sheet W-312-S2A, on Type L single-stage volute No. 8 centrifugal pump. Also, several other specification sheets on single-stage and two-stage volute centrifugal pumps.

Power Transmission—E. F. Houghton & Co., Philadelphia, Pa. A 148-page booklet entitled "Vim Short Center Drives."

Speed Reducers. W. A. Jones Foundry and Machine Co., 4401 West Roosevelt Road, Chicago, Ill. Bulletin No. 53, Herringbone-Maag speed reducers for small motor drives.

Centrifugal Pumps. LeLaval Steam Turbine Co., Trenton, N. J. Catalog B-2, describing single-stage double-suction pumps.

Wire Rope. John A. Roebling's Sons Co., Trenton, N. J. Wire rope and wire.

Drill Sharpener. Sullivan Machinery Co., 400 North Michigan Ave., Chicago, Ill. Bulletin No. 72-P, portable drill sharpener, Class "E."

Blast Gates. General Electric Co., Schenectady, N. Y. Bulletin GEA-1435, blast gates for low pressure air and gas systems.

Welding. General Electric Co., Schenectady, N. Y. Bulletin No. GEA-995B supersedes 995A, "Arc Welding in Industry." Also Bulletin GEA-1440 on arc welders.

Ball Bearings. New Departure Manufacturing Co., Bristol, Conn. Price and data book.

Apron Feeders. Link-Belt Co., Chicago, Ill. Book No. 1351 on heavy-duty apron feeders.

Fencing. Page Steel and Wire Co., Bridgeport, Conn. Booklet entitled "The Border Patrol."

Sling Chains. American Chain Co., Inc., Bridgeport, Conn. Standard specifications book.

Cementation. Dravo Contracting Co., Pittsburgh, Pa. Bulletin No. 301, cementation process.

Power Transmission. Rockwood Paper Pulley Stores, Inc., 77 Chambers St., New York. Book on short-center flat belt drives.

Dryers. C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland, Ohio. Bulletin No. 69, describing eleven styles of dryers.

Motors. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. Leaflet No. 20525, Model MC, steel mill-type motors.

NEWS OF THE INDUSTRY

Freight-Rate Rise May Cost Mines $2,000,000 a Year

Non-ferrous metals and minerals would pay approximately $2,000,000 a year if the rate increases proposed by the U. S. Interstate Commerce Commission become effective. This estimate is based upon tonnage shipped in the year ended June 30 last. Under the specific increase of $3 a car the non-ferrous ores and concentrates would contribute approximately $550,000 additional as follows:

Copper ore and concentrates, $230,000; lead ore and concentrates, $98,000; zinc ore and concentrates, $81,000; other ores and concentrates, $150,000. Slated for an increase of $6 per car, phosphate rock would contribute $579,000 and sulphur $168,000 to the total.

Although not specifically listed in the Commission's report, the non-ferrous metals would be subject to an increase of 2c. per 100 lb. that applies to all carload freight except farm products. On this basis copper ingot, pig, and matte would pay $203,000; copper, brass and bronze bar, sheet and pipe, $126,000; lead and zinc ingot, pig and bar, $404,000; and aluminum, $5,000. The increases apply to all carload shipments regardless of length of haul.

Less-than-carload shipments of non-ferrous minerals and metals would pay an increase of 1c. per 100 lb. on hauls over 175 miles and including 250 miles, and 2c. per 100 lb. beyond 250 miles. Through shipments will take only one increase. This applies to through shipments moving on a combination rate. Lake iron ore will be subject to a double levy; first on the rail-haul to Lake head and then from the Lower Lake port to furnace. Special adjustment on this traffic is probable, but this and other details probably will not be worked out until the railroads come to an agreement with the Commission on the plan for pooling increased revenue derived from the rate increases and the conditions under which it will be distributed among the roads which are not now earning their interest charges.

■

Alaskan Platinum Possibilities

Production of alluvial platinum from the District of Goodnews Bay, south of the Kuskokwim River mouth, Alaska, is reported to be around 1,000 oz. Had the price of platinum held at around $100 an ounce, each miner would have made from $7,000 to $15,000, according to Irving McKay Reed, who has completed a survey of this area and the lower Yukon country for a report to the Territorial Mining Department.

Six men have been working on Clara Creek branch of the Goodnews River, four on Squirrel Creek, two on Platinum and one on Fox Creek. The ground is wet and not frozen and bedrock has nowhere been reached, all work thus far being done by hand methods. Bedrock is estimated at an average depth of 25 ft. The presence of iridium in most of the diggings brings the average value up to about $30 an ounce.

Considering the amount of prospecting and mining being done, the returns are most favorable and, in Mr. Reed's opinion, the district warrants further prospecting and development.

■

U.V.X. Valuation Decision

Yavapai County superior court has decided that the value of the United Verde Extension property should be placed at $5,710,000 for taxation purposes for 1931, and the State has filed notice of appeal. The Attorney General claims that the valuation should be between $8,000,000 and $9,000,000.

■

Witherite Found in Alaska

Discovery of a deposit of witherite in southeastern Alaska by George Comstock has been announced recently by B. D. Stewart, the territorial supervising engineer. The mineral was first noted by Comstock as a deposit of pebbles on the beach, of which several tons were gathered and found upon testing to be nearly pure barium carbonate, with no metallic content. The property is on Kuiu Island, about 90 miles south from Juneau. This is the first known deposit of witherite in Alaska, and the third on the continent of North America —the other two being in Kentucky and Ontario. Mr. Stewart will examine the property.

■

Develop Stibnite Near Ketchikan

A deposit of stibnite is being developed by the owner, Val Klemm, on the mainland about 15 miles west of Ketchikan, Alaska. The property is on the east side of Point Camano, about half a mile from the shore of Bond Bay. The deposit occurs beside a schistose acid dike in dark blue massive limestone forming an ore zone averaging 3 to 4 ft. in width and continuing as far as stripping has exposed the vein. No other metal besides antimony has been found in the ore. A test shipment of one ton to the Selby smelter at San Francisco, Calif., gave the following return: antimony, 44.8 per cent; sulphur, 12.6; arsenic, 00.5; iron, 00.0; and insoluble, 14.8.

Pecos Drill Cuts New Ore at 250 Ft. Below 10 Level

Diamond drilling from the south port of the No. 10 level of the Pecos zinc-lead mine, near Tererro, N. M., has indicated ore at a depth 250 ft. below that level. This hole is said to be the most highly mineralized drill hole ever put down at the property, and shows a zinc content ranging from a trace to more than 30 per cent through a considerable part of its 375 ft. The discovery of this ore proves that the main ore zones do not bottom above the No. 10 level, as had been feared, and confirms the theory that Pecos oreshoots are plunging to the south. The property, largest zinc-lead-gold producer in the State, is controlled by American Metal.

From the position of the ore, which lies to the west of the Cucaracha oreshoot, it appears that it may be a downward continuation of the Katydid orebody, which had appeared to peter out at about the No. 8 level. More drilling will have to be done to determine its extent, however, before the company makes plans for further development in depth. The drill hole showed one width of 17 ft., along the hole, under the Cucaracha body, and one width of 28 ft. further west, both of which carried zinc ore averaging about 14 per cent zinc. The lead content of the second oreshoot, as is characteristic of the Katydid oreshoot, is comparatively low.

Development of the Nos. 9 and 10 levels of the property has proceeded north and south of the shaft along the Evangeline-Cucaracha shear zone. To the north, the No. 9 level opened ore, but drill holes near the face encountered considerable water, and the work was stopped. On the No. 10 level, no sizable length of ore was found north of the shaft. A raise, put up to check drill results, cut a good-sized oreshoot about 40 ft. up. This will be thoroughly explored in the hope of determining its downward trend. The company has hopes of finding ore east of the shaft, as the dip of the shear zone, which had been slightly to the west in the upper, flattens out to the east below the No. 8 level and is only 40 to 45 deg. from horizontal.

South of the shaft, development has yielded more favorable results on both levels, the south face on the No. 9 showing some excellent ore. This is in the Cucaracha orebody. Production is at the rate of about 550 tons of ore daily.

■

Small Mill for Arnette Gold

West of Yuma, Calif., E. W. Myers is reported to be constructing a 40-ton mill for W. D. A. Arnette, who expects to supply it with gold ore from the Arnette property.

Urquhart Discusses Production Plans for Mount Isa and New Guinea Goldfields

Mount Isa, giant new Australian lead producer, should be producing at capacity, and New Guinea Goldfields, pioneer operator of the gold lode deposits at Wau, New Guinea, should be operating its pilot mill on high-grade ore, by the middle of 1932, according to Leslie Urquhart, chairman of the board of directors of Mining Trust, which controls both properties. Mr. Urquhart, who recently visited New York, was interviewed by an *E.&M.J.* representative. He stated that for the present Mount Isa will not join the European lead cartel.

Because it is a new mine and also, probably, the largest lead mine in the world, Mount Isa should be allowed to reach its stride before being called upon to curtail, Mr. Urquhart declared. Its present rated capacity of 6,000 long tons of lead a month is small, he pointed out, in comparison with its known reserves of 30,000,000 tons of ore. However, the company will be glad to cooperate with the cartel as far as possible and will follow the policy adopted by American Smelting & Refining. The latter organization has a large interest in Mining Trust, in addition to being responsible for the technical direction of the Mining Trust properties. The companies will market their lead in the English market through a joint agency.

At present Mount Isa is producing about 3,300 tons of lead monthly. With reference to the difficulties experienced in the smelter, which have been the chief handicap in production, Mr. Urquhart explained that a large proportion of the ore being smelted is lead carbonates and that the metallurgy of this ore has had to be worked out. The company is handling the carbonates because, being zinc-free, there will be no waste of zinc content. No provision has yet been made for the recovery of zinc in sulphide ores or for the treatment of the copper oreshoots found in a parallel lode. Improvement in the prices of both zinc and copper will be necessary before the company considers the recovery of these metals. In the meanwhile, Mr. Urquhart declared that one of the most satisfactory features of current operations is that the grade of the ore is considerably higher than was indicated by diamond drilling, the difference ranging from 1 to 1½ per cent lead content, or an additional 20 lb. per ton of ore treated.

The new lead refinery in England, which will desilverize Mount Isa pig lead, is now in operation and is producing lead of exceptional purity. It occupies an 8½-acre site on the Thames, near London, and is equipped to handle 75,000 long tons of refined lead a year. This capacity can be doubled at an expense of less than $100,000, as all provisions have been made for such enlargement save the actual installation of additional furnace and pouring capacity. Mr. Urquhart pointed out that when the company has been established on a normal basis of 6,000 tons a month, it will be possible to make more definite plans for the future. Eventually, he said, production will be much higher.

By the end of this year, New Guinea Goldfields should have its new power plant in operation at its properties in the Wau gold district, according to Mr. Urquhart. Development operations have been considerably hampered by the lack of an adequate power supply, particularly in attempting to open the deposits on the upper, or plateau, area at depth. The small pumps have been able to cope with only a limited flow of water. Development of air transportation, which now makes it possible for the company to ship in items weighing up to 3 tons apiece, will facilitate power-plant construction.

Although development at depth of the plateau deposits is opening ore of higher grade than was indicated on the surface, Mr. Urquhart said the company is not yet in a position to determine the extent to which the property should be equipped. A 100-ton mill is being built to handle ore from the surface deposit at Location No. 14 on the lower area. More than 100,000 tons of ore assaying 25 dwt. in gold per ton has been developed there. If the plateau deposits prove to contain sufficient ore to warrant exploitation, they will probably be connected to the mill by a cable tramway system, as no mill site is available in the plateau area.

Production of gold by the leasers on the company's alluvial area is running about $75,000 a month, Mr. Urquhart said, of which about $30,000 is profit. This is being used for development work. In addition, the company expects to make substantial profits from exploitation of the No. 14 area. Surveys for construction of a road from the coast to the mine have been completed. The distance will be about 48 miles. At one point the road rises to 5,500 ft. and then drops precipitously to 3,600 ft. Construction will probably cost $750,000, but will not be undertaken until a better idea of the magnitude of the property is available. It will take one and a half years to build.

■

Cleary Hill Plans New Mill

After extensive development since 1924, when the property was taken over from the Rhoades-Hall company, Cleary Hill Alaska Mines, operating on Bedrock Creek, northeast of Fairbanks, Alaska, has opened enough ore to erect a small stamp mill at once. Under the Rhoades-Hall management this mine yielded high-grade gold ore, but the orebodies played out and were thought to be exhausted. The present owners picked up the vein again. A crew of fifteen men has been working this year.

In building the proposed mill, all freight and supplies possible will be shipped to the property by auto truck over the Richardson Highway from Valdez, because of the recent raise in rates by the Alaska Railroad. Although the mine is 400 miles from Valdez, all dynamite used has been shipped thus at a saving of $4 a box over the rail rate on that class of freight. In addition, perishable supplies were received at their destination two days sooner than if shipped over the Alaska Railway. Local mining men consider the raise in freight rates a mistake.

■

Phelps Dodge to Operate C. & A. Smelter at Douglas

Announcement has been made that the Copper Queen smelter of Phelps Dodge at Douglas, Ariz., is to be shut down as soon as the ore on hand has been smelted. Mine production that the Copper Queen has been treating will be sent to the former C. & A. smelter, where operations will be expanded to take care of the extra tonnage. At present about 300 men are employed at each plant. About 450 will be needed when operations are unified. Both plants are operating at 50 per cent of capacity, and both are modern, having been enlarged and improved in recent years. The main reason for continuing operations at the C. & A. plant was its acid unit.

Facilities for smelting lead ore are available at the Copper Queen smelter, but they will not be used at present, because of the prevailing low price for lead. The shutdown will be completed by Dec. 15.

■

Alaskan Mine Ships Gold Ore and Concentrate by Plane

Development of several new gold-bearing veins in the Nabesna Gold Mining property, on the Nabesna, tributary of the Tanana River, Alaska, has resulted in steady shipments of high-grade ore. Owing to its isolation, north of the Wrangell Range, the mine has shipped both crude ore and concentrates from the company mill by airplane. The plane operates between the mine and Copper Center or Chitina across the Wrangell Mountains, carrying loads from 1,500 to 2,000 lb., and thence by the Copper River & Northwestern railroad to Valdez.

According to Carl Witham, owner of the property, 10 tons of concentrates averaged nearly $2,000 per ton, and crude-ore shipments run to twice that value and more. The successful operation of the Witham mine has greatly stimulated prospecting on the Nabesna and adjacent creeks such as Slate Creek. Across the Nabesna from the Witham property, three prospectors, Brown, Gerken, and Anderson, have uncovered a gold-silver-lead vein of good width.

■

Add Cyanide Unit to Kelly

Near Randsburg, Calif., the flotation mill at the Kelly property, formerly operated by the California Rand Silver Company, has been rehabilitated and a 200-ton cyanide unit erected. Plans contemplate the use of half the capacity of the mill in custom work and half for the company ore. Leasers are active in the Randsburg district.

Baltic Mine, Nearing Its End, Yields Good-Grade Ore

Copper Range, operating in the Michigan copper district, is producing approximately 1,250,000 lb. of refined copper monthly, production being off about 50 per cent. The Champion mine's output is 1,000,000 lb. monthly, and Baltic is getting out 250,000 lb. Baltic is in the final stages of abandonment, the copper rock now mined coming from pillars in the upper levels. The rock is returning a high average yield, as the upper part of the mine is richer than the openings at depth. The mine will probably be worked throughout the winter. Both Champion and Baltic are working only four days a week.

Drilling is still proceeding in Globe lands, south of Champion, in which an encouraging showing of ore has been revealed in holes already drilled. Only one hole is now being driven, which will complete the diamond-drill program planned for the year. The drill is approaching the vein, the southerly extension of the Baltic lode. More drilling may be done next summer, but this has not yet been definitely decided. Drilling operations the last two years have been successful in indicating values in the Isle Royale, Ashbed, and Baltic formations, giving encouragement for the opening and exploration of new commercial ground.

Copper Range's marketing problem has been solved through its purchase of a substantial interest in C. G. Hussey & Company, of Pittsburgh, operators of Pittsburgh copper and brass rolling mills. Most of the Copper Range product, if not all, will go to this concern, giving Copper Range a share also in the profits of manufacture.

■

New Montana Gold Producers Promise to Swell Output

Interest in gold mining is manifesting itself in Montana by the promise of a considerably increased production. Leading Montana in high-grade gold production is the August mine, in the Little Rocky Mountains, in the northern part of the State, with shipments running from $7,500 to $14,000 in gold per railroad car of 40 tons each. This property is a closed common-law trust controlled by Charles Whitcomb, Holter Brothers, and Charles Powers, of Helena, prominent mining men, merchants, and bankers. Four additional gold-mining ventures are gradually swinging into production.

Lincoln Gulch Placer has installed equipment to treat 2,000 cu.yd. daily of placer ground from the Taum placers, in the old camp of Lincoln, 50 miles northwest of Helena.

California-Alder Gulch Corporation has just completed a combination electrically driven shovel and dragline. The company is running a drainage ditch and excavating for sluice boxes and screening equipment, preparatory to production from Alder Gulch, near Virginia City, 72 miles southeast of Butte. This company controls some 3,000 acres in the gulch proper.

Test runs are now being made by Ohio-Keating at its 80-ton cyanide plant, at Radersburg, which will handle gold ore, averaging $8 a ton, under the direction of C. L. Hewitt, of Helena. This is the first cyanide plant to be built in the State in many years.

At Gold Creek, in the Pioneer district, 60 miles northwest of Butte, Gold Creek Mining is finishing the installation of a 6,000 cu.yd. daily capacity, Yuba floating dredge, which is to be electrically driven and operate on a large acreage of placer ground. In this district gold was first discovered by Granville Stuart. The present company is sponsored by prominent capitalists of Chicago, Milwaukee, and Columbus, Ohio.

■

Noranda's Gold Reserves Grow

In the first nine months of 1931, the value of gold production at the Noranda Mines property, Rouyn, Que., exceeded the value of copper output in that period, a quarterly report issued by the company states. In addition, development is steadily adding to reserves of gold ore. One section of the "H" orebody has 60,000 tons averaging $35 a ton in gold, as well as 2.4 per cent copper. In addition, "G" orebody has 750,000 tons of fluxing ore running $4 a ton in gold. At the old Chadbourne property, where development was suspended several years ago, four drill holes have recently been put down. Three of these show material running from $2.20 to $5.20 a ton in gold over widths of 50 to 140 ft.

■

Syndicate Opens Cane Springs Mine

A syndicate, headed by George H. Short, Duncan MacVichie, and R. C. Wilson, of Salt Lake City, has started operations at the Cane Springs and Alvarado properties at Gold Hill, Utah. A headframe has been shipped, along with a gasoline engine, to the Cane Springs mine, where the company will drift on the lowest level to open up the old stope 70 ft. below the point where operations stopped in early days. Two carloads of ore have been shipped during the last two months from the old stope by leasers.

Prosposals to Aid Rand Mines Placed Before Union

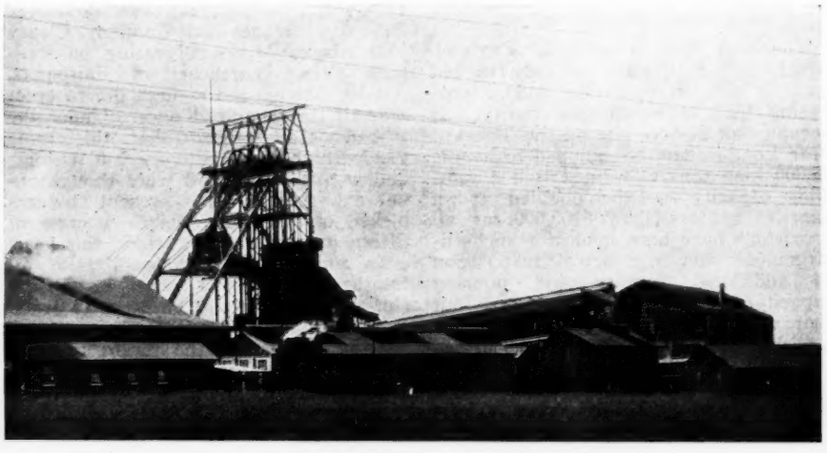
Johannesburg, Nov. 2.—Proposals for new mining legislation and for amendments to existing laws designed to aid in the development of additional properties in the Witwatersrand and other South African gold fields are now being considered by the legal and technical advisers of the Union government. The prosperity of the Union of South Africa, which alone among the leading nations is not affected by the depression, results largely from the fact, of course, that more than 45 per cent of the income tax collections of the Union are based on gold mining, and gold mining has been helped rather than hindered by depression. No better argument could be advanced by gold miners to prove the importance of maintaining the industry than this prosperity.

. . . . Sir John Martin, chairman of the board of directors of New Modderfontein, stated at the annual meeting of the company that in the past the mine has more than fulfilled the highest expectations entertained. The turn of the tide, which is shown in lowered ore reserves and grade, and the drop in profits, is likely to cause a greater degree of disappointment than is justified. Even now, he said, an estimate of the tonnage to be milled at this property in the future is impossible, because of the unknown possibilities of the various reefs.

. . . . At the annual meeting of Sub Nigel, highest-grade gold producer in the Transvaal, D. Cristopherson, chairman, stated that the management has planned to increase development work with the object of placing ore reserves five years ahead of mill requirements of 400,000 tons annually. At June 30, reserves were 1,206,000 tons averaging 17.3 dwt. per ton in gold. Development continues to show very gratifying results, and he characterized the mine's outlook as satisfactory.

. . . . Reorganization of operations at City Deep, which has cut the tonnage milled from about 95,000 tons to about 80,000 tons monthly, has resulted in lower costs. As a result, the mine is again showing profits, after losing money for the last two and a half years.

The City Deep mine surface plant, on the Central Rand



Claims Staked in Swayze Area as Reports Are Favorable

More than 350 claims have been recorded and another 150 claims are reported to be staked, but not yet recorded, in Swayze, Dore, Rollo, and Denyes townships, northwest of Sudbury, Ont., as a result of a promising gold discovery by J. G. and J. L. Kenty, brothers, who have been prospecting in that area under a joint contract with Brett Trethewey Mines, Ltd., Northland Prospectors, and Northern Canada Mining Corporation, Ltd. The discovery was made on Aug. 18. Five tons of supplies, including several cases of dynamite, have been rushed into the Kenty claims by airplane, and a crew of men, with J. G. Kenty in charge, is engaged in opening up and extending the original exposures. A third brother, Miner Kenty, of Cobalt, has optioned a group of claims adjoining the original find on the northeast to Cyril Knight Prospecting Company, which has shipped in three tons of supplies and has a crew of men actively prospecting the claims for an extension of the original discovery.

On receipt of word of the Kenty discovery, the Ontario government immediately dispatched H. C. Rickaby to the scene of the find, and a preliminary report of Mr. Rickaby's investigations has been published. The Kenty group of 15 claims in the northeast corner of Swayze Township has now five showings, all quartz veins ranging from 3 to 8 ft. in width, exposed at intervals over a distance of about 2,000 ft. Rich specimens of visible gold were taken from some veins, and both the quartz and wall rock yielded some gold, according to the Provincial Geologist's report. The whole mineralized zone is about ¾ mile in width.

Prominent exploration engineers and companies interested in this area since the Kenty find include: F. M. Connell and associates; Cyril Knight Prospecting Company; Percy E. Hopkins; Col. C. D. H. MacAlpine, of Dominion Explorers; Ventures; Consolidated Mining & Smelting; R. A. Bryce, of Toronto; and Prospectors Airways.

■

Geological Survey Reports on Alaska Railroad District

Important reserves of gold, silver, lead, and zinc are contained in the region served by the Alaska Railroad, the U. S. Geological Survey reports after a summer of intensive studying of the region. In addition, non-metallic deposits, not now producing, exist which may at some future date be of economic importance. Nine separate surveys were made, most of them with regard to the gold deposits in the Fairbanks, Valdez Creek, Willow Creek, and other areas.

J. M. Hill, who surveyed the Fairbanks district, points out that no work on the gold lodes there has penetrated below 300 ft. Four mines are now producing. Definite evidence is available that the veins contain primary gold that should continue to depths considerably below any so far reached. In addition, the area has important possibilities for producing from large, low-grade lodes. The Ryan lode is known to contain more than 1,000,000 tons averaging between $4 and $5 a ton.

At Eva Creek, 11 miles east of Ferry, Eva Creek Mining is installing a mill to treat a small body of high-grade ore. Prospecting of the surrounding district is suggested in the hope of discovering similar orebodies. In the Mount Eielson area, an ore-bearing zone, 6 miles long and from ½ to 1 mile wide, carries sphalerite, galena, and chalcopyrite. Little development has been done, and the possibilities of developing a large tonnage are unknown.

Five mines are now producing in the Willow Creek district, of which the largest is the Lucky Shot, where from 80 to 100 men are employed. The veins resemble those in certain California districts and give reason for hoping that they persist to great depth. Present workings are shallow.

■

Tom Reed Acquires American

Tom Reed Mining has taken over the United American mine, at Oatman, Ariz. The two properties are adjacent, and the 950 level of the Tom Reed connects with the bottom of the United American 1,000-ft. shaft. A large blower is being moved to this shaft, which will be used for exhausting vitiated air from the workings. A prospect winze will be sunk on the American vein from the 950 level. Rock will be hoisted through the Tom Reed shaft. The 1,225 level at the Tom Reed is now being developed, and stoping will soon be started.

■

Errington Ore Cut at 1,500 Ft.

Persistence of Treadwell Yukon in continuing underground drilling and development at the Errington mine, near Sudbury, Ont., has been rewarded by a drill intersection yielding lead-zinc-copper assays across a width of 35 ft. The intersection was obtained in a horizontal hole from an exploratory drift at the 1,500 level. Further diamond drilling is proposed in an endeavor to follow the ore, believed to be the downward continuation of one of the orebodies developed at the 500 level.

Lake Shore Ore at Depth Virtually Continuous

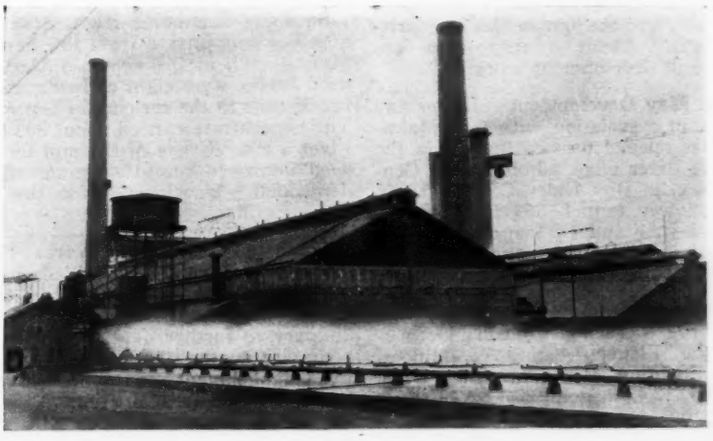
In the 2,490 ft. of drifting along the No. 2 vein on the 2,000 level of the Lake Shore mine, at Kirkland Lake, Ont., ore was opened up having a total length of 2,300 ft., according to E. B. Knapp, mine superintendent, in the annual report. Widths on the 1,800 and 2,000 levels are better than the mine average, and the grade is equal to that in the upper levels, Mr. Knapp states. Broken ore reserves have been increased to $6,850,000, but the change in mining methods to the cut-and fill system will gradually remove the necessity for these reserves.

During the company's fiscal year, ended June 30, the program of raising mill tonnage to more than 2,000 daily was completed. A total of 698,624 tons of ore was treated, yielding bullion worth $9,152,935. The quarterly report for the period ended Sept. 30 shows production of $2,780,000 or at the rate of about $11,220,000 annually. According to the *Northern Miner*, 1,000 ft. of ore averaging 45 ft. wide and $20 in gold a ton has been opened on the 2,200 level. Work is now proceeding to a depth of 3,000 ft.

Changes in metallurgical practice at Kirkland Lake may result in higher recoveries and lower costs than have been prevailing. Lake Shore is now building a mill addition that will permit concentrating the ore by flotation at a ratio of about 50:1 and cyaniding the concentrate. In addition, a similar plant, with a capacity of 1,500 tons daily, will be built on the north side of the lake to treat tailing from the Wright-Hargreaves and Lake Shore dumps. The two companies and Lee Dougan and W. H. Englebright, metallurgists, are interested in this new enterprise. The entire tailing output of the two companies will be available.

Although to give figures on the average grade of this material is not yet possible, Wright-Hargreaves' reports indicate that its mill tailing must average considerably over $1 a ton. To June 30, Lake Shore had treated 2,336,571 tons, and Wright-Hargreaves, to Dec. 31, 1930, had treated 1,441,485 tons, a total for the two mines of 3,778,056 tons. Whether it will be practicable to recover the entire tonnage is questionable.

The Copper Queen smelter, at Douglas, Ariz., which is being closed as a result of the recent Phelps Dodge—C. & A. merger—see p. 423 for details



BRIEF NOTES

Beattie Plans New Mill. Depending on the results of negotiations for financing the property, a first mill unit will be built and underground development undertaken at the Beattie gold property, in Duparquet Township, Que. This property has been extensively diamond-drilled by Ventures, Ltd., and it is believed that eventually as much as 5,000 tons of ore daily will be handled. The first mill unit will probably handle from 700 to 1,000 tons daily.

Big Belt Drives on Tunnel. Big Belt Mining, operating placer ground in Magpie Gulch, near Canyon Ferry, Mont., is running its main drainage tunnel and is now 2 ft. above bedrock and about 50 ft. from its No. 1 shaft. The gravel at this point is running from 3c. to 37c. per pan. Fifteen men are employed.

Consolidated M. & S. at Dog Lake. Consolidated Mining & Smelting has a crew of fifteen men under George Cameron prospecting a new discovery of gold on the south shore of Dog Lake, a few miles west of Missinaibi, near Franz, Ont., on the main line of the Canadian Pacific Railway. Sufficient supplies to last until after the freeze-up have been moved into the property by motor-driven scows. Entry of Consolidated into this area has been followed by a wave of staking, more than 150 claims having been recorded at Sault Ste. Marie.

Cuba Ships to McGill. Shipments have been started from the Cuba Consolidated Mining property, 1½ miles from Ely, Nev., to the McGill smelter of Nevada Consolidated Copper. The ore, which is desirable for smelting because of its excess silica content, assays $6 to $7 a ton in gold. The tunnel is being advanced on the vein and raises are being put up every 25 ft. to the orebody, which lies in the limestone bed cut by the vein. A tractor installation is being used successfully to haul the ore. Thomas S. Wilson, of Ogden, Utah, is president and manager and John A. Smith, of Ely, vice-president and superintendent.

Leadhill Mines Adds Claims. Two groups of claims north of its holdings on Slate Creek, in the Metaline Falls zinc-lead district, in Washington, have been acquired by Leadhill Mines, controlled by Bunker Hill and Hecla Mining. The groups are the Knob Hill, comprising six claims, and the Jennie Dee, comprising eight. About twenty men are engaged in development work.

Little May Developments. Little May Mining, in association with Gus Malmborg, has opened up two tunnels in the old Raft River mine, adjoining the Century mine, in Box Elder County, Utah. In the lower tunnel, 369 ft. from the portal, 5 ft. of mineralization has been cut, and in an upper tunnel, the company is raising on 14 in. of gold ore.

Mineral Veins Ore Shipped. A carload of ore was shipped during October from the Flagstaff mine of Mineral Veins Coalition Mines at Alta, Utah, assaying $12.45 in gold, 23.3 oz. of silver to the ton, 24.5 per cent lead, and 25 per cent iron. A carload of 45 per cent lead carbonate ore was also shipped from the West Toledo property. Leasers are mining ore from a vein above the Wasatch Drain tunnel and also from a rich quartzite vein in the Rexall property of the company.

Montana Metals Ore Returns. Montana Metals, of which Ben Jackson, of Three Forks, is president, recently shipped a car of ore from its Mighty Monarch property, near Radersburg, Mont., which assayed 3.66 oz. gold and 33.5 oz. silver per ton. Net smelter return for the car was $2,166.78.

Mount Coolon Ore Rich. Ore reserves on the Mount Coolon Gold property, near Collinsville, Queensland, are estimated at 106,000 long tons, averaging 90s. in gold a ton, above the 300 level, by J. C. Coldham, manager. The ore deposit has been traced on the surface for nearly 2,000 ft., with ore widths ranging from 3 to more than 20 ft. On the 300 level of the Native Bear lease, development indicates that ore continues to greater depth. Mine operating costs are estimated at 25s. per ton down to the 300 level. Ore is amenable to fine grinding and cyanidation. The cost of equipping with a mill and power plant is estimated at £145,000.

Nevada County Mines Starts. At Nevada City, Calif., J. M. Hoff has started operations for the Nevada County Mines, Inc., and is operating the St. Louis mill, which has been equipped with flotation cells and is receiving ore from several claims.

Oro Fino Placers Optioned. J. W. Donahoo and W. T. Gilbert, of Wichita Falls, Tex., have optioned the Oro Fino placers, on the Hassayampa River, near Wickenburg, Ariz. They will install machinery and begin operations during November. These placer deposits were large producers in the latter part of the nineteenth century, and about 7,000,000 cu.yd. of gold-bearing gravel is reported to be still available. A dragline will be installed to handle the gravel.

Riverside Leases Three Groups. Riverside Mines & Metals, in association with T. B. Elliott, has leased the Hercules property, north of Murphys, Calif.; the Lucky Jim, east of San Andreas; and the Glencoe, east of Mokelumne Hill. Exploration of all three will be started in the near future.

Sunshine Shipments High. Shipments of silver concentrate from the Sunshine Mining mill, in the Coeur d'Alene district, Idaho, were eight carloads, averaging 55 tons to the carload, in September. The concentrate carried about 800 oz. of silver a ton. Grade of the mill feed has been improved recently by sorting underground. Development on the 1,700 level continues.

Tombstone Ex. Shaft Work. Tombstone Extension Mining will deepen its main shaft at the property, 2 miles east of Tombstone, Ariz., to 475 ft., preliminary to further development of orebodies at depth. This will be followed by establishment of a new working level, and systematic drifting on the vein known to extend to this depth. Sinking of the additional 200 ft. in the shaft is being done on contract. Operations to date have been at a profit, owing to the high-grade ore mined.

Treadwell Yukon Ships Plant. Treadwell Yukon has shipped a small mining plant, consisting of steam boiler, compressor, and hoist, good for a depth of 500 ft., from Sudbury into the Massicotte-Boussiere option in Louvicourt Township, northwestern Quebec, where a crew of men have been grappling with difficulties of heavy overburden for more than a month. A small shaft will be sunk to develop gold deposits. Little progress has been made with the program of surface trenching, and diamond-drilling results have been inconclusive. F. W. Bradley, accompanied by V. C. Clauson, is examining the property.

U.V.X. to Reopen Haynes Shaft. Development work in the Haynes claim, where some good copper assays were obtained early in the year, is being continued by United Verde Extension at Jerome, Ariz. The work is being done through a deep level of the United Verde property. No commercial orebody has yet been discovered, but the prospect justifies plans for reopening the Haynes shaft and sinking it deeper. This work will be costly and will reduce the company's cash reserves.

Vipond Works at 1,450 Ft. Exploration work was the principal feature of the Vipond Consolidated gold operations, at Porcupine, Ont., during the year ended July 31, 1931. No attempt was made to estimate ore reserves at the end of the year, though at the beginning they stood at 163,525 tons and 107,290 tons was milled. The chief development undertaken was the sinking of the main shaft from 1,200 to 1,450 ft. and the driving of two long crosscuts east and west. Some new ore was found on the 500 and 600 levels.

Develop Sonora Placer Area

According to news received at Bisbee, Ariz., systematic development of the gold placer area discovered recently on the southeast slope of the Ajo Mountains, about 49 miles southeast of Cananea, Son., Mexico, will be undertaken by Gold Ribbon Mining, headed by Kentucky interests. Preliminary exploration work, extended over a period of fourteen months, includes 2,327 test holes. Samples assaying from $5 to $30 a ton were recovered by dry-washing processes.

Activities at present are concentrated upon the building of a dam, 250 ft. long and 75 ft. high, and the installation of a network of pipe lines, to provide water for the operation of the field. Water for domestic use at the camp now under construction is to be obtained from a smaller dam to be built a short distance below the main dam. About eighty men are employed at the present time. R. Crawford, of Flagstaff, Ariz., is engineer in charge of operations. Executive officers of the company include Dr. P. D. Harvey, J. B. Harvey, R. Crawford and C. U. Smith.

The Balatoc mine and mill, near Baguio, Philippine Islands, where a new tunnel is being driven at mill level to open the orebodies at depth. Mill capacity has recently been doubled to 300 tons daily.

A. C. Beatty Discusses Rhodesia Before New York Engineers

A. Chester Beatty proved an outstanding attraction at the monthly meeting of the New York section, A.I.M.E., held at the Commodore Hotel, on Wednesday, Oct. 28, for the meeting was the best attended of any in recent years, with about 250 present. Robert E. Tally made a brief talk, contrasting the progress that has been made in improving the technology of mining and metallurgy of copper during recent years with the lack of equivalent progress in developing consumptive channels and in efficient marketing and production control. Dr. H. Foster Bain, retiring secretary of the Institute, made a short farewell talk and alluded briefly to his new position as managing director of the Copper and Brass Research Association. He was presented by some of his associates with a Tiffany watch. J. V. W. Reynders and E. De Golyer, as well as A. B. Parsons, the incoming secretary, made brief remarks.

Mr. Beatty told the story of the discovery of the Roan Antelope, with brief reference to the geology of the property and the mining and metallurgical methods employed. He summarized the ore reserves of the various properties, giving data already published in these columns, except for N'Changa, which he referred to as having 85,000,000 tons of ore developed. Roan was now operating at about 60 per cent of capacity, he said, and Mufulira and N'Kana expected to be producing early next year. Northern Rhodesia was referred to as containing about 500,000,000 tons of blocked-out ore averaging about 4 per cent copper.

■

Broken Hill South Reserves

Broken Hill South, operating on the Barrier, New South Wales, Australia, reports a drop in ore reserves to 4,000,000 long tons on June 30, 1931, compared with 4,250,000 at the end of the previous fiscal year. Production during the year was 334,500 tons, indicating development of less than 100,000 tons. Expenditure on new plant and equipment during the year amounted to £112,146. The new No. 7 shaft is now complete to 1,470 ft. and the hoists are expected to be in operation in December. Mill construction has been completed. Grade of lead concentrate was raised to 72.3 per cent, compared with 67.5 per cent the previous year. Zinc-concentrate grade rose 1 per cent to 50.7 per cent. Costs of mining, development, and treatment were cut to 30s. 1.2d. per ton, compared with 35s. 5d. the previous year. W. E. Wainright, the general manager, states that no development work was done during the year on large known orebodies at the southern end of the mine, which accounts for the drop in reserves.

■

Report Boulder County Activity

More than four hundred men are now engaged in prospecting and mining in the hills of Boulder County, Colo., according to a statement received from the Service Bureau of the Boulder County Metal Mining Association. This compares with about a hundred men earlier in the year. Shipments to the local sampler are reported to be 300 per cent above last year's mark. The Service Bureau of the association was formed last June. It acts as a clearing house through which mine owners can be put in touch with prospective buyers and leasers. A complete file of mines and mining activities in the county is maintained.

■

Sees Possibilities at Tambor

"In my opinion, the El Tambor region presents special characteristics that warrant a careful exploration, for which, however, an important investment of capital will be necessary. The treatment on an industrial scale, by modern methods, of the ore of the region should develop a great source of gold production." This statement was made by Osvaldo Gurria Urgell, inspector for the mines department of the Mexican Ministry of Industry, Commerce, and Labor, in his report covering an examination of the El Tambor region, San Ignacio municipality, Sinaloa, where discoveries of gold last spring created a great deal of interest. Although declaring that no doubt can exist about the richness of El Tambor, Sr. Urgell believes heavy investments in modern mining machinery and equipment must be made before the fields can be exploited on an adequate scale.

Trepca Ore on 730 Level Wide But Low Grade

London, Nov. 3.—Trepca Mines reports that the first crosscut on the 730-meter level of its Stantrg lead-zinc mine, in Yugoslavia, showed ore 31 m. (or about 100 ft.) wide. The average grade was 9.1 per cent lead and 7 per cent zinc, compared with the usual average of about 25 per cent of both metals combined. Mill recovery in the third quarter was 96.37 per cent of the lead content and 85.49 per cent of the zinc content of the ore. The mill is treating about 800 metric tons daily.

. . . . The claim for exemption from tin-restriction schemes made by Pahang Consolidated, operating in the Federated Malay States, has been dismissed by the Chief Justice of the F.M.S. The company had asked for compensation from Penang State if it was compelled to restrict exports of tin concentrate.

. . . . Operating costs at Taquah & Abosso, second largest gold producer on the Gold Coast, are being steadily reduced and are now down to about 23s. a ton. Output in the September quarter was £43,697 (excluding premium) from 28,874 tons of ore. New development showed ore of lower than average grade, 596 ft. averaging 30s. 9d. per ton having been opened in a total of 1,002 ft. Both Nos. 18 and 19 levels are being extended north in ore averaging about 31 to 34s. a ton.

. . . . Sinai Mining, which operates Egyptian manganese deposits, is revising its capital structure and issuing £62,500 of debenture stock carrying no fixed interest, which will be given to holders of ordinary stock at 5s on their par. The present stock, of £1 par value, will be reduced to 10s. and additional stock issued to bring the total capitalization up to £300,000.

. . . . Before the end of November, construction of the new 7,000-ton concentrator at the N'Kana property of Rhokana Corporation is expected to be complete. In addition, the company expects to be able to resume driving in the workings of the N'Changa West deposit, recently flooded.

. . . . Roan Antelope is producing blister copper that averages 99.6 per cent copper from its new smelter, put into operation last month. Roan Antelope blister will not be refined electrolytically, its gold content being small.

MARKET AND FINANCIAL NEWS

World Platinum Accord Announced in London

A world platinum accord was announced in London Oct. 22. The accord results from a new English company—Consolidated Platinums Ltd.—having concluded contracts to buy and resell virtually all the new platinum production originating in U.S.S.R., Canada, South Africa, and Colombia, constituting the major portion of the world's output of this precious metal.

One of the new company's major functions will be to promote the use of platinum through an intensive research and market development program and to facilitate cooperation between distributors, producers, and consumers in this effort.

The company concluded its contracts after six months of negotiations in London among the principal producers in U.S.S.R., Canada, South Africa, and Colombia, including Edelmetalle-Vertriebs Aktiengesellschaft, Mond Nickel Company, Ltd.; Johannesburg Consolidated Investment Company; New Consolidated Gold Fields; and Compania Minera Choco Pacifico.

The company will be managed by a committee consisting of representatives of the companies named in the foregoing, with P. L. Ginsburg and E. B. Howard White as joint managers.

Sale of platinum which the newly formed company will buy will be through existing distributors and dealers; thus, there will be no change in present distribution methods.

When asked about platinum prices, a member of the management committee gave an opinion to the press, but emphasized that he was not attempting to represent the views of the company. He said:

"Of course, no one can forecast the future price of platinum, since in the last analysis it must always reflect market conditions. The present price, however, is a fair one both from the standpoint of producers and consumers, and having due regard to the cost of production and other factors involved, I can see no reason why it should not remain for some time at the present level. Obviously, variable and rapidly fluctuating prices are extremely undesirable both to the producer and consumer of platinum. It is expected that the new company, by reason of its understanding of market conditions and its promotional efforts on behalf of this metal, will be able to coordinate production and consumption and to effect a much needed stability in the industry."

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54
1928	99.78
1929	110.33
1930	82.87

	1929	1930	1931
January	106.86	102.94	67.62
February	110.37	102.28	65.90
March	122.71	99.93	68.03
April	116.36	93.24	64.45
May	110.03	83.41	59.81
June	109.66	78.57	58.23
July	109.58	74.58	59.54
August	109.81	74.41	58.05
September	109.29	73.42	57.09
October	106.52	69.63	55.08
November	106.09	71.39	.....
December	104.75	70.65	.....

■

B. H. South Shows Loss for Fiscal Year

Broken Hill South, second largest lead producer in Australia, reports an operating loss of £20,452 in the fiscal year ended June 30, 1931. After deduction of depreciation charges and addition of income from investments, the company showed a net profit of £50,277, as compared with £282,268 in the previous year. The company paid two dividends totaling £60,000 during the year and reports a balance of £124,841 to carry forward. Production was 66,319 long tons of lead concentrate, assaying 72.3 per cent lead and 28.3 oz. of silver a ton, and 18,948 tons of zinc concentrate, assaying 50.7 per cent zinc. Production of zinc concentrate was suspended from Aug. 2, 1930, to April 20, 1931. The company reports total assets of £2,560,366, of which £686,004 is shares in other companies at cost and £280,046 represents metals on hand.

World Lead Production Reduced in September

Production of refined lead for the world during September amounted to 109,629 tons, against 121,010 tons in August, and 114,419 tons in July. Owing to the revision in August production statistics for the United States and Australia, the total for August in the latest compilation is somewhat higher than the figures announced a month ago. The daily rate of production for September, according to the A.B.M.S. figures, was 3,654 tons, against 3,906 (revised) in August, and 3,691 tons in July.

World refined lead statistics for July, August, and September, in short tons, follow:

	July	August	September
United States	32,157	(*d*) 34,144	31,966
Canada	10,412	10,209	10,262
Mexico	18,421	21,434	16,629
Germany	8,557	9,732	9,736
Italy	2,385	1,699	2,157
Spain and Tunis (*a*)	6,993	7,574	6,715
Europe (*b*)	15,500	15,800	15,600
Australia	12,096	(*d*) 12,520	8,266
Burma	6,698	6,698	6,698
Elsewhere (*c*)	1,200	1,200	1,600
Totals	114,419	(*d*) 121,010	109,629

(*a*) Partial. (*b*) Not elsewhere specified and partly estimated. (*c*) Estimated or partly estimated. (*d*) Revised.

Production of base bullion by Mount Isa, Australia, has been as follows in short tons: June, 877; July, 2,476; August, 2,536; September, 2,560. This does not appear in the current statistics, the latter being on the basis of refined lead.

■

Receipts of Lead in Ore

Total intake of lead in ore by United States smelters during September amounted to 34,186 tons, according to the American Bureau of Metal Statistics. This compares with 33,881 tons of lead in August, 34,273 tons in July, and 51,869 tons in September, 1930. Receipts of lead in ore and scrap, in tons, for July, August, and September, follow:

Ore Receipts	July	Aug.	Sept.
United States	30,136	33,385	33,228
Mexican ore	639	2	42
Elsewhere	42	916	958
Totals	34,273	33,881	34,186

Receipts of lead in scrap, inclusive only of scrap smelted in connection with ore, totaled 3,386 tons in September, 3,539 tons in August, and 3,117 tons in July.

Look to Copper's Future, Say Tariff Advocates

Washington, D. C.—Domestic producers seeking a tariff on copper urged the Tariff Commission at a hearing Oct. 28 to consider the present condition of the industry in making its report to Congress. They argued that a report limited to a mere recitation of domestic and foreign costs during 1928, 1929, and 1930, as called for in the Senate resolution directing the investigation, would be of little significance without also considering the threat to the domestic industry of the tremendous increase in foreign production and foreign productive capacity.

W. W. Lynch, former manager of sales of United Verde, stated that domestic producers are asking for a tariff with the full knowledge that statistics of the past show little indication of its need. The domestic industry, he said, had resigned itself to the loss of export markets owing to amazing expansion abroad and needs a tariff to protect the domestic market from invasion. Chairman Fletcher announced from the bench that the Commission's report would present as complete a picture of the present situation, with its background, as is possible in the limited time available. No data bearing on costs or other factors were released by the Commission at the hearing, as it has not been the Commission's practice, since its reorganization a year ago, to issue any statements on its fact-finding preliminary to its final reports.

Chairman Fletcher stated that the Commission would welcome any information on costs and wages in the Belgian Congo and Rhodesia, and Commissioner Broassard asked for annual reports of the companies operating in Africa, explaining that the Commission has some but not all.

The testimony presented at the hearing by Mr. Lynch, Clinton Bernard, chief of the exploration department of the General Development Company, and A. E. Petermann, representing Phelps Dodge, Calumet & Hecla, and other Michigan producers, related almost wholly to the apprehension created by increasing foreign productive capacity. Mr. Bernard explained that foreign producers have not followed the lead of American producers in curtailing production in an attempt to meet the current depression. He presented statistics demonstrating that though domestic production has been cut to 40 per cent of the 1929 peak, foreign production again reached a peak in September, 1930, and now amounts to 80 per cent of that figure. Asked by Chairman Fletcher whether domestic producers are not now making an effort to prevail upon foreign producers to curtail output, Mr. Bernard replied that he did not know anything about it, except what he had read in the newspapers. By 1933, he said, foreign production would be 500,000 tons in excess of foreign consumption.

Explaining that the comparability of foreign and domestic costs would be destroyed if depletion and depreciation are included, Mr. Petermann suggested that in the Commission's cost data depletion and depreciation should be set up separately. He recommended that the procedure to be followed in this connection should be determined by experts of the Commission and the industry in conference.

■

Quarterly Reports

HOWE SOUND, operating in Mexico and Canada, reports net income of $99,860 in the quarter ended Sept. 30, 1931. Total income was $227,611 and operating income was $99,006. Value of metals produced was $1,896,268. Production of zinc was unchanged and production of lead, copper, silver, and gold was lower than in the second quarter. In the second quarter, net income was $127,467.

MAGMA COPPER, operating in Arizona, reports a net loss of $91,739 in the Sept. 30 quarter. The company suspended production during the quarter, and reports a production of only 2,457,851 lb. of copper.

SISCOE GOLD, gold producer in Quebec, reports operating profit, before taxes or depreciation, of $124,634 in the third quarter of 1931, on a gross production of $220,868. Production for nine months is $555,705.

AMERICAN ZINC, LEAD AND SMELTING, operating in Illinois, Tennessee, and other states, reports a net profit after all charges of $68,980 in the Sept. 30 quarter. For the nine months, profit was $325,014.

LAKE SHORE MINES, gold producer in Ontario, reports a net profit, after depreciation and taxes, of $1,503,187 in the Sept. 30 quarter. Production was $2,780,759. The company will pay a dividend of $1 a share, equal to the original capitalization, on Dec. 15.

CALUMET & HECLA CONSOLIDATED, Michigan copper producer, reports gross income of $1,338,130 in the third quarter of 1931, which, after expenses and taxes, was turned into a loss of $201,282. If depreciation charges are included, the loss was $403,318, compared with a profit of $85,633 in the corresponding period of 1930. For the year to date, the company shows a net loss, including depreciation but not depletion, of $1,148,541.

■

El Oro Mining in 1931

In the fiscal year ended June 30, 1931, El Oro Mining & Railway reports a net profit of £34,203, which compares with £45,399 in the previous year. The company, formerly operator of a silver mine at El Oro, Mexico, now has its chief interest in the La Noria mine, at Zacatecas. During the year this property treated 172,124 metric tons of ore in its mill, from which 6,296 tons of concentrate averaging 15,072 grains of silver and 15 grains of gold was produced. In addition, 31 tons of high-grade ore was shipped direct. Costs were reduced to $5.08 a ton and, at the end of the year, were $4.31.

■

U. S. Quicksilver Imports

According to the Department of Commerce, no importations of quicksilver into the United States were made during August of the current year. Imports for the first eight months of the year amounted to 27,054 lb., valued at $32,649, against 162,506 lb., valued at $213,169, in the same period last year.

Zinc Production of the World

(American Bureau of Metal Statistics)

The following table shows production of zinc, unallocated according to the origin of the ore, except for United States and Mexico. To complete the world's accounting by months, the production in Belgium reported as an aggregate for the first six months of the current year has been averaged. This makes for some distortion of the totals for May and June. The daily rate for the world for September was 2,815 tons, against 2,768 tons in August, 2,860 tons in July, and 4,133 tons in September, 1930. All figures are in short tons.

	May	June	July	Aug.	Sept.
United States	25,688	23,483	21,365	21,467	21,356
Mexico	3,630	3,184	3,255	3,172	2,875
Canada	12,049	11,226	10,450	9,416	9,797
Belgium (a)	(c) 13,252	(c) 13,252	12,635	12,042	11,990
France	6,004	5,786	5,707	5,171	4,980
Germany (a)	3,354	3,015	3,096	4,198	4,183
Italy	1,409	1,436	1,593	1,264	1,193
Netherlands	1,935	1,769	1,746	1,737	1,587
Poland (a)	13,887	13,417	12,017	10,618	10,155
Spain	972	936	957	946	914
Australia	7,263	6,255	6,847	6,500	6,318
Rhodesia	1,137	1,148	.....	.....	.....
Elsewhere (b)	9,000	8,900	9,000	9,200	9,100
Totals	99,580	93,807	88,668	85,731	84,448
United States	25,688	23,483	21,365	21,467	21,356
Elsewhere	73,892	70,324	67,303	64,264	63,092

(a) Includes zinc dust. (b) Partly estimated; includes Norway, Yugoslavia, Czechoslovakia, Russia, Indo-China, and Japan. (c) Average of six months' total.

Copper Official Advocates Change in Trust Laws

The right to control production of copper, lumber, oil, and other basic commodities was held essential for the normal development of industry at a conference of trade leaders held recently at New York University. The relation of law and business was the subject under discussion at the meeting.

Touching on the problems of the copper industry, Cornelius F. Kelley, president of the Anaconda Copper company, in line with other speakers, pointed out that potential productivity exceeded consumptive capacity. To meet this situation, he said, American industry demanded that it be given at least an equal opportunity to maintain itself at home and sustain itself in the export markets of the world.

Mr. Kelley favored the enactment of a statute vesting the right to protect business and the public primarily in the Department of Commerce. He favored modification, rather than repeal, of the Sherman anti-trust law, however. He indicted that law on three counts:

1. The Supreme Court in applying the law has given it an interpretation not in accordance with the purposes and intent of Congress in enacting it.

2. The Sherman law fails to meet the ordinary requirements of a penal statute, in that it fails to prescribe with reasonable certainty the elements of the offense.

3. The Sherman law acts to obstruct and prevent business organizations from taking such proper and reasonable action as should be taken when it might prove effective in meeting the abnormal conditions with which industry is periodically faced, and thereby prolongs the length and severity of depression.

Pointing out the basic importance of the copper industry, Mr. Kelley said:

"The importance of its production to the national economy elsewhere than in the United States is recognized and favored, even to the extent of governmental aid and subsidies. At home every effort that the industry has made toward self-help has been the subject of investigation, intimidation, and threatened prosecution under the anti-trust laws, until today it is in a state of chaos —a condition which, while an apparent reflection upon the intelligence of those who direct it, is in fact chiefly due to the doubt, hesitation, and fear of becoming involved in violating the actual or supposed prohibitions of the law.

"Eliminating producers whose output is less than 1,000,000 lb. a month, the total number operating in the United States under normal conditions is about 20, and there are approximately 35 outside our borders. The percentage of the total production ranges from a maximum of 20 per cent to 25 per cent controlled by one group, to less than one-half of 1 per cent made by the individual members of the smaller units.

"No unit is sufficiently dominant to have a substantial effect in regulating production. None is in a position of control except to the extent of its individual output. In times of prosperity the united production of all has been required to satisfy consumptive demand. In times of depression only a fraction of the total production can be used."

Mining Company Dividends for October, 1931

Companies in the United States	Situation	Per Share	Total Disbursements
Aluminum Company of America, pfd	Various	$1.50Q	$2,214,930
Bunker Hill & Sullivan, pfd., l, s	Idaho	0.50MK	3,740
Calumet & Arizona, c	Arizona, New Mexico	2.50F	2,107,143
Cresson Consolidated, g	Colorado	0.01Q	12,000
Granite Gold	Colorado	0.01	16,005
Homestake Mining, g	South Dakota	0.65M	163,254
Kennecott Copper	Various	0.25Q	2,343,031
Magma Copper	Arizona	0.25Q	102,039
Tom Reed Gold Mines	Arizona	0.03Q	60,000
U. S. Smelting, Refining & Mining	Various	0.25Q	121,587
U. S. Smelting, Refining & Mining, pfd	Various	0.875	425,557
Companies in Other Countries			
Dome Mines, g	Canada	0.25Q	238,333
Hollinger Consolidated Gold	Canada	0.05M	246,000
Howe Sound, c, l, z	Canada, Mexico	0.50Q	248,020
Lucky Tiger-Combination Gold, s	Mexico	0.03Q	21,460
New York & Honduras Rosario, s, g	Honduras	0.25Q	50,000
Pioneer Gold	Canada	0.03Q	50,000
Premier Gold	Canada	0.03Q	150,000
Wright-Hargreaves, g	Canada	0.02½Q	137,500
Total			$8,710,599

c, copper; s, silver; l, lead; g, gold; z, zinc; Q, quarterly; M, monthly; SAS, semi-annual, includes 5 per cent stock divided; X, extra; F, final.

■

Speculative Operations in Metals Expand

Dr. James Rubinfeld
Berlin

Sterling exchange fluctuations are holding the center of interest in the market for non-ferrous metals in Germany. Speculative operations have broadened somewhat as a result of the confusion in exchange. The world-wide uncertainty over the currency outlook has increased the desire to accumulate supplies of raw materials. In Germany, operators are wary lest changes now going on in the economic structure might lead to another period of inflation. A clause has been inserted into the bylaws of the Berlin Metal Exchange that recognizes the uncertainties surrounding the economic situation. Difficulties in executing contracts that might arise from sudden economic changes shall constitute, the clause holds, a case of *force majeure*.

The conference of copper producers now being held in New York, together with the possibility of a United States tariff on copper, may result in a period of more numerous price changes. But with so many other important issues coming up for settlement in the near future, traders are inclined to view the developments in copper with great reserve. The huge stocks are expected to depress the market for some time.

Development work in the metal industry is virtually at a standstill because of the low prices prevailing. Plans to extend the capacities of electrolytic copper refineries in Germany have been abandoned for the present. The poor market for zinc has forced the Giesche company's elaborate program out of the picture, though nothing official has been said to indicate that the project has been abandoned. The poor call for zinc products is expected to result in further world restriction of production.

The workers at Mansfeld Copper, Eisleben, have finally agreed to accept another 10 per cent reduction in wages. The new wage schedule, effective Oct. 1, will expire on the last day of March, 1932.

Silver currency is being minted in a larger way in Germany. So far as can be learned, Germany has already secured most of the silver necessary for minting the new 5- and 7-mark coins.

The French coal and iron concern of de Wendel has acquired the majority interest in the Austrian Veitscher Magnesit. The latter company is an important factor in the Austrian magnesite industry.

Negotiations for the prolongation of the European aluminum cartel are coming to a close, and it is generally expected that the members will be able to agree as to terms.

■

Vipond Profits Drop

Vipond Consolidated, gold producer in Ontario, reports production of $712,856 in the year ended July 31, 1931, on which an operating profit of $133,896 was realized. Depreciation and other charges brought the net profit down to $67,728. Operating profit in the previous year was $385,974 on an output of $896,397. Output in the 1931 fiscal year was 107,290 tons of ore, yielding $6.64 a ton. At the end of the year the company had net current assets of $821,404, not including stock in Huronian Mining & Finance.

Call for Copper, Lead, and Zinc Improves—Silver Higher on Speculative Buying

New York, Nov. 5, 1931.—The major non-ferrous metals sold in good volume in the last two weeks, though most of the activity occurred in the first half of the period. Buying of copper was inspired largely by the feeling that something constructive may result from the deliberations of producers now in progress. Soon after the price of lead fell to 3.75c., New York, consumers decided to accumulate some metal. This they did by taking on approximately 12,000 tons of lead in the week ended Oct. 28, close to a record tonnage for so short a time. Zinc also sold in a large way, but at lower prices. Interest in silver continues to grow and the price again moved upward on support from speculators. Quicksilver was dull and barely steady at $70 to $72 per flask. Tin was unsettled on the almost daily fluctuations in sterling exchange. A world platinum accord was announced in London recently.

Copper Holds at 7c.

Demand for copper increased materially, owing, apparently, to the fact that the curtailment conference was being held here. Small consumers, especially, seemed to feel that the time was ripe to enter the market at 7c. a little more actively than they had hitherto. It seems probable that more copper was sold in the week ended Oct. 28, in the domestic market, than in any other week this year, with possibly one exception. An exact statement cannot be made, as reports from two large producers were lacking. It seems likely that the producers who did not report booked between 10,000 and 15,000 tons during the week on the 7c. basis, and approximately 8,000 tons was reported sold by others.

The export price was maintained at 7½c., c.i.f usual European ports. Export sales for the month of October totaled 32,250 long tons, against 19,000 long tons in September. Since the first of the current month foreign sales have been small.

The October statistics are expected to make an unfavorable showing, but few in the industry appear to be disturbed, owing to the great importance that is being attached to the negotiations now in progress to restrict output further. Producers appear to be making some progress at the negotiations now on, and this has lifted sentiment quite a little, especially in the last day or so. All of the important producers, according to copper authorities, are pretty much in accord about bringing output down to a point somewhat below the current rate of consumption.

Lead Active

The feature in the market for lead was the heavy buying that occurred in the week ended Oct. 28, when approximately 12,000 tons were sold, the largest weekly total since the record mark of 13,400 tons established for the week ended June 24 of the current year. Consumers evidently felt that lead at less than 4c. per pound was a good buy, and in more than one instance buyers endeavored to cover a good part of their forward requirements—that is, well into 1932. Producers, on the other hand, limited their offerings to near-by lead.

A gradual hardening of prices, resulting from the firm stand taken by leading sellers to restrict daily sales at prevailing prices to current intake, made buyers even more anxious about obtaining lead. The New York quotation advanced from 3.75c. to 4c. during the period, with a corresponding gain in St. Louis. At the higher level, however, the buying subsided and prices again eased off, settling at 3.85c., New York, and 3.65c., St. Louis. Sales of lead were larger in October than in any month since June. Actual shipments to consumers during October may not be as large as in September.

Zinc Lower

Reports indicate that the buying of zinc for the calendar week ended Oct. 31 was quite substantial, the sales total for the period exceeding 6,000 tons. Despite this heavy volume of business, the price tapered off further, at least one transaction going over at 3.125c., St. Louis, a new low for the movement. The low was reached on Oct. 30. In the last day or so the market quieted down, a few hundred tons selling on the basis of 3.15c., St. Louis. The European cartel has reduced output another 5 per cent, making total curtailment 50 per cent.

Tin Unsettled

Demand for tin improved slightly, but prices realized were somewhat lower. The market was unsettled throughout the period, owing chiefly to the uncertainty surrounding the position of sterling exchange. United States deliveries of tin in October totaled 5,385 long tons, against 5,015 long tons in September. The world's visible supply at the end of October was estimated at 50,602 long tons, against 50,722 long tons a month previous.

Silver Advances

The silver market advanced steadily, settling at 31¼c. an ounce, a new high for the movement. The uplift was due almost entirely to continued support from speculators who cling to the belief that the metal is to figure largely in the reconstruction of British and other currency systems.

Average Metal Prices for October, 1931

COPPER:	
Electrolytic, refinery	6.775
London Standard, Spot	34.957
London Electrolytic, Bid	41.000
LEAD:	
New York	3.964
St. Louis	3.773
London Spot	13.227
London Forward	13.270
SILVER:	
New York	29.538
London	17.153
Sterling Exchange	388.029
ZINC:	
St. Louis	3.377
London Spot	12.733
London Forward	13.216
TIN:	
Straits	22.723
London Standard Spot	126.932
QUICKSILVER	72.385
ANTIMONY	6.517
PLATINUM, Refined	40.000
CADMIUM	55.000
ALUMINUM, 99 Per Cent Plus	23.300

Zinc and Lead Concentrates

The Joplin, Mo., market for zinc concentrate declined to $18 per ton for Prime, base 60 per cent, following the weakness in the metal. Lead, basis 80 per cent, settled at $40 per ton.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c.

ANTIMONY—Per lb., duty paid. Chinese, spot, 6.50c.; futures, 6.37½c.

BERYLLIUM—See Alloys.

BISMUTH—Per lb., in ton lots, $1.15.

CADMIUM—Per lb., 55c.

IRIDIUM—Per oz., $100@$105 for 98@99 per cent sponge and powder.

NICKEL—Per lb., electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal.

PALLADIUM—Per oz., $19@$21.

PLATINUM—Per oz., official price of leading interest, $40. Cash transactions between dealers and refiners several dollars less. London, £9 14s., nominal.

QUICKSILVER—Per 76-lb. flask, $70@$72. The market was a dull affair and prices were more or less nominal at the range quoted. London quotes £19 15s. per flask for spot material.

(*Continued on page 432*)

Daily Prices of Metals

Oct. Nov.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
22	6.775	23.00	3.75	3.525	3.30
23	6.775	22.70	3.75	3.525	3.30
24	6.775	22.70	3.75	3.525	3.25
26	6.775	22.85	3.75@3.80	3.575	3.25
27	6.775	22.875	3.75@3.90	3.625@3.675	3.25
28	6.775	23.00	4.00	3.80	3.225
Av'ge	6.775	22.854	3.808	3.600	3.263
29	6.775	22.70	4.00	3.80	3.175
30	6.775	22.625	4.00	3.80	3.15
31	6.775	22.50	4.00	3.80	3.15
2	6.775	22.25	3.85	3.65	3.15
3	Holiday	Holiday	Holiday	Holiday	Holiday
4	6.775	22.20	3.85	3.65	3.15
Av'ge	6.775	22.455	3.940	3.740	3.155

Average prices for calendar week ended October 24, 1931, are: Copper, 6.775c.; Straits tin, 22.842c.; New York lead, 3.792c.; St. Louis lead, 3.575c.; Zinc, 3.292c.; Silver, 29.875c.

Average prices for calendar week ended October 31, 1931, are: Copper, 6.775c.; Straits tin, 22.758c.; New York lead, 3.933c.; St. Louis lead, 3.738c.; Zinc, 3.200c.; Silver, 30.125c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

Oct.	Sterling Exchange "Checks"	Silver		Gold, London	Oct. Nov.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
22	3.93	29½	16 11/16	104s 6d	29	3.86	29⅞	17⅜	106s 8d
23	3.91	30	17 5/16	105s 8d	30	3.85½	30⅝	17 13/16	107s 3d
24	3.90	29¾	17 3/16	.....	31	3.82¼	30¾	18 3/16	.....
26	3.92½	30	17¼	105s 3d	2	3.74½	31	18½	108s 2d
27	3.87½	29⅝	17 3/16	105s 9d	3	Holiday	Holiday	19 3/16	111s 5d
28	3.89	29⅞	17 5/16	105s 9d	4	3.74¼	31¼	18⅞	110s 3d

Average for week ended October 28: Silver, 29.792c.; Sterling exchange, $3.90500.

Average for week ended November 4: Silver, 30.700c.; Sterling exchange, $3.80500.

New York quotations are as reported by Handy & Herman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables commanded one-half cent premium at noon on Nov. 2.

London

Oct. Nov.	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
22	35 13/16	36 9/16	41½	127⅛	129⅝	13⅜	13¼	13	13⅜
23	36⅜	37 3/16	41½	126½	129¼	13 7/16	13 5/16	13	13⅜
26	36⅝	37⅜	41½	126⅝	129⅜	13⅜	13¼	13 1/16	13½
27	35 15/16	36 11/16	41½	127⅛	129⅜	13⅜	13 5/16	13	13 5/16
28	36	36¾	41½	127⅛	129⅝	13½	13 7/16	13 7/16	13 9/16
29	35¾	36½	42	126⅝	129⅛	13 7/16	13 7/16	13 5/16	13½
30	35	35½	41	127⅛	129½	13 7/16	13⅜	13¼	13 7/16
2	35⅜	36 1/16	42	127⅜	129⅝	13½	13½	13⅜	13⅞
3	36⅛	36⅞	42	129¼	131¼	13¾	13 11/16	13 7/16	13⅞
4	35 11/16	36 5/16	41	128	130⅛	13 9/16	13½	13 3/16	13 11/16

Prices for lead and zinc are the official price for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Chromium, Indium, Lithium, Magnesium, Manganese, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Silicon, Tantalum, Tellurium, Thallium, Titanium, and Tungsten are unchanged from prices given in the Oct. 26 issue.

Metallic Ores

Prices in tons of 2,000 lb., or in "Units" of 20 lb., unless otherwise stated.

BERYLLIUM ORE—Per ton, minimum 10 per cent BeO, $20@$30, f.o.b. mines. Supplies more than adequate. In small lots for export, $20@$60 per ton, depending upon quality and quantity of the material offered.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $17.50 for 46@48 per cent Cr_2O_3 ore, and $19.50@$20 for 50@51 per cent ore.

TUNGSTEN ORE—Per unit of WO_3, New York; Chinese wolframite, duty paid, $11@$11.25. Bolivian scheelite, $11.25@$11.50; domestic scheelite, $10.50@$12. Nominal.

Antimony, Iron, Manganese, Molybdenum, Tantalum, Tin, Titanium, Vanadium, and Zircon ores are unchanged from prices given in the Oct. 26 issue.

Non-Metallic Minerals

Non-metallic mineral quotations are unchanged from those given in the issue of Oct. 26.

Metallic Compounds

COPPER SULPHATE—Per lb. in carloads, 3.40c., f.o.b. New York.

Prices on Arsenious Oxide, Calcium Molybdate, Cobalt Oxide, Germanium Dioxide, Sodium Nitrate, Sodium Sulphate, Zinc Oxide, and Zirconium Dioxide are unchanged from those in the Oct. 26 issue.

Refractories

Refractories unchanged from prices quoted in Oct. 26 issue.

Alloys

BERYLLIUM—Per lb. of contained Be, $50, chiefly sold as an alloy of 12 per cent Be and 88 per cent Cu.

Prices on other alloys unchanged from those given in the Oct. 26 issue.

Rolled Metals

Rolled metals unchanged from prices quoted in Oct. 26 issue.

Sterling Exchange, 90-Day

Beginning Oct. 13, Sterling exchange, 90-day demand, has been as follows:

Oct. 13th, $3.89; 14th, $3.87; 15th, $3.86; 16th, $3.84½; 17th, $3.85½; 19th, $3.87; 20th, $3.93; 21st, $3.95; 22d, $3.93; 23d, $3.91; 24th, $3.90; 26th, $3.92½; 27th, $3.88; 28th, $3.91; 29th, $3.86½; 30th, $3.86¼; 31st, $3.82¼; Nov. 2d, $3.74½; 4th, $3.74.

Metal Statistics

Monthly Average Prices of Metals

(See daily price table for basis of quoting)

Silver

	New York		London Spot		Sterling Exchange	
	1930	1931	1930	1931	1930	1931
January	45.000	29.423	20.896	13.810	486.447	485.260
February	43.193	26.773	20.008	12.432	485.784	485.551
March	41.654	29.192	19.298	13.524	485.933	485.596
April	42.428	28.279	19.554	13.120	486.019	485.764
May	40.736	27.650	18.850	12.858	485.724	486.188
June	34.595	27.250	16.049	12.707	485.625	486.291
July	34.346	28.255	15.928	13.197	486.300	485.349
August	35.192	27.524	16.283	12.815	486.839	485.284
September	36.315	28.180	16.738	14.101	485.888	451.245
October	35.846	29.538	16.563	17.153	485.719	388.029
November	35.908	.....	16.625	.....	485.454	.....
December	32.635	.....	15.201	.....	485.413	.....
Year	38.154	.....	17.666	.....	485.929	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery		London Spot			
	Electrolytic		Standard		Electrolytic	
	1930	1931	1930	1931	1930	1931
January	17.775	9.838	71.469	44.938	83.250	47.524
February	17.775	9.724	71.419	45.372	83.500	47.950
March	17.775	9.854	69.202	44.818	83.405	47.699
April	15.621	9.392	62.075	42.694	74.338	45.375
May	12.756	8.665	53.159	38.897	59.545	42.175
June	12.049	8.025	50.003	35.827	56.750	38.966
July	11.023	7.698	48.277	34.402	52.522	37.293
August	10.693	7.292	47.525	32.572	50.725	35.388
September	10.310	6.988	46.264	31.503	49.500	36.148
October	9.597	6.775	43.030	34.957	45.772	41.000
November	10.113	.....	46.134	.....	48.963	.....
December	10.300	.....	46.771	.....	50.065	.....
Year	12.982	.....	54.611	.....	61.528	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1930	1931	1930	1931	1930 Spot	1930 3 Mos.	1931 Spot	1931 3 Mos.
January	6.250	4.802	6.100	4.604	21.545	21.571	13.872	13.905
February	6.236	4.552	6.086	4.340	21.188	21.097	13.444	13.550
March	5.662	4.527	5.542	4.276	18.807	18.940	13.128	13.355
April	5.537	4.412	5.428	4.164	18.319	18.363	12.375	12.606
May	5.523	3.818	5.408	3.651	17.795	17.861	11.491	11.778
June	5.410	3.917	5.310	3.761	17.941	17.994	11.582	11.952
July	5.250	4.400	5.149	4.225	18.160	18.063	12.731	12.899
August	5.488	4.400	5.340	4.225	18.294	18.178	11.944	11.994
September	5.500	4.400	5.348	4.217	17.909	17.798	11.932	12.026
October	5.151	3.964	4.999	3.773	15.747	15.674	13.227	13.270
November	5.100	.....	4.950	.....	15.954	15.931	.....	.....
December	5.100	.....	4.950	.....	15.283	15.292	.....	.....
Year	5.517	.....	5.384	.....	18.077	18.064	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin and Cadmium

	New York		London		Cadmium
	1930	1931	1930	1931	1931
	Straits		Spot		
January	38.851	26.137	175.466	115.798	67.115
February	38.675	26.315	173.750	117.919	55.000
March	36.798	27.065	164.851	121.852	55.000
April	36.077	25.222	162.638	112.775	55.000
May	32.108	23.221	144.818	104.331	55.000
June	30.336	23.478	136.300	104.966	55.000
July	29.822	24.978	134.511	111.478	55.000
August	30.044	25.738	134.988	114.875	55.000
September	29.647	24.618	132.631	117.813	55.000
October	26.802	22.723	117.451	126.932	55.000
November	25.904	.....	113.519	.....	.....
December	25.262	.....	111.560	.....	.....
Year	31.694	.....	141.873	.....	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1930	1931	1930 Spot	1930 3 Mos.	1931 Spot	1931 3 Mos.
January	5.229	4.035	19.634	20.241	12.747	13.113
February	5.180	4.012	19.209	19.778	12.303	12.694
March	4.934	4.002	18.304	18.810	12.190	12.676
April	4.843	3.717	17.819	18.378	11.353	11.838
May	4.641	3.306	16.639	17.330	10.484	10.875
June	4.441	3.416	16.422	17.038	11.270	11.750
July	4.350	3.893	16.171	16.777	12.280	12.802
August	4.360	3.817	15.953	16.469	11.444	12.028
September	4.270	3.744	15.773	16.080	11.571	12.063
October	4.050	3.377	14.446	14.935	12.733	13.216
November	4.266	.....	14.706	15.238	.....	.....
December	4.099	.....	13.762	14.214	.....	.....
Year	4.556	.....	16.570	17.107	.....	.....

St. Louis quotations, cents per pound. London pounds sterling, per long ton.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1930	1931	1930	1931	1930	1931
January	8.606	7.317	121.192	103.000	61.923	36.000
February	8.830	7.069	120.500	100.205	59.909	34.000
March	8.236	7.127	118.808	100.423	54.769	29.538
April	7.740	6.888	114.000	102.077	46.462	26.346
May	7.454	6.524	117.269	101.140	46.000	24.980
June	7.057	6.342	118.600	92.058	46.000	37.115
July	6.976	6.802	117.462	85.808	43.692	40.000
August	7.839	6.596	116.000	80.115	41.462	40.000
September	7.773	6.542	113.620	76.300	36.080	40.000
October	7.288	6.517	110.596	72.385	36.000	40.000
November	7.105	.....	106.717	.....	36.000	.....
December	7.099	.....	105.346	.....	36.000	.....
Year	7.667	.....	115.009	.....	45.358	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1930	1931	1930	1931	1930	1931	1930	1931
January	19.00	17.50	18.50	17.00	18.50	17.00	24.300	23.300
February	19.00	17.29	18.50	16.79	18.50	16.79	24.300	23.300
March	19.00	17.00	18.50	16.50	18.50	16.50	24.300	23.300
April	19.00	17.00	18.50	16.50	18.50	16.50	24.300	23.300
May	19.00	17.00	18.50	16.38	18.50	16.44	24.300	23.300
June	19.00	17.00	18.50	15.50	18.50	16.00	24.140	23.300
July	18.62	17.00	18.12	15.50	18.12	16.00	23.300	23.300
August	18.50	17.00	18.00	15.50	18.00	16.00	23.300	23.300
September	18.38	17.00	17.76	15.50	17.88	16.00	23.300	23.300
October	17.85	16.92	17.00	15.42	17.22	16.00	23.300	23.300
November	17.50	.....	17.00	.....	17.00	.....	23.300	.....
December	17.50	.....	17.00	.....	17.00	.....	23.300	.....
Year	18.53	.....	17.99	.....	18.02	.....	23.787	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade
[1]F.o.b. Mahoning and Shenango Valley furnaces; freight to Pittsburgh, $1.76

Monthly Crude Copper Output in Short Tons

	1929	1930	1931 June	1931 July	1931 Aug.	1931 Sept.
Domestic						
Alaska shipments	21,947	18,953	1,303	1,048	748	2,090
Calumet & Arizona	65,246	45,161	.....	.....	.....	.....
Magma	19,118	15,940	1,437	1,229	.....	.....
Miami	29,567	34,568	2,174	2,032	.....	.....
Nevada Consolidated	133,140	70,990	(d) 16,504	.....	.....	.....
Old Dominion (a)	11,172	10,428	600	575	539	.....
Phelps Dodge (b)	111,026	72,308	5,178	5,179	5,166	.....
United Verde Extension	29,669	21,908	1,642	.....	.....	.....
Tennessee Corporation	7,870	7,772	833	742	.....	.....
Foreign						
Andes Copper	60,538	47,428	3,498	.....	.....	.....
Braden	88,155	79,923	8,593	8,595	.....	.....
Boleo, Mexico	12,898	13,940	(d) 3,107	.....	.....	(d) 3,283
Chile	(c) 150,247	89,100	7,122	.....	.....	.....
Furukawa, Japan	17,767	18,536	1,505	1,431	1,427	.....
Howe Sound	21,516	22,633	(d) 4,001	.....	.....	.....
Messina	(c) 7,100	(c) 7,600	870	832	897	.....
Mt. Lyell	9,731	10,878	.....	.....	.....	.....
Sumitomo, Japan	20,180	15,429	1,286	1,255	1,260	955

(a) Includes Arizona Commercial. (b) Moctezuma is included. (c) Fiscal year. (d) Three months.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1929 Monthly Production	1929 Daily Rate	1930 Monthly Production	1930 Daily Rate	1931 Monthly Production	1931 Daily Rate
January	86,324	2,785	67,838	2,188	48,059	1,550
February	84,735	3,026	59,196	2,144	47,504	1,697
March	93,698	3,023	61,216	1,975	48,702	1,571
April	94,902	3,163	60,450	2,015	46,452	1,548
May	93,392	3,013	60,238	1,943	45,580	1,470
June	82,354	2,745	56,743	1,891	44,473	1,482
July	79,229	2,556	54,249	1,750	38,228	1,233
August	78,885	2,545	56,779	1,832	38,925	1,256
September	79,402	2,647	56,584	1,886	38,088	1,270
October	82,575	2,664	55,954	1,805	.....	.....
November	75,934	2,531	53,141	1,771	.....	.....
December	74,772	2,412	48,518	1,565	.....	.....
Total	1,006,203	....	690,263	....	396,011	....
Monthly average	83,850	....	57,522	....	44,001	....
Av. of daily rate	.....	2,757	.....	1,891	.....	1,451

Mining Share Prices—Month of October, 1931

Company Name	High	Low	Last	§Most Recent Dividend
NEW YORK STOCK EXCHANGE				
Alaska Juneau	16	10	15	Oc. 10, No. 2, 1931....Q 0.10
American Metal	8.50	6.62½	7.50	December, 1930....Q 0.25
Am. Metal, pfd	36	21	21	Au. 22, Se. 1, 1931....Q 1.50
Am. Sm. & Ref.	28⅜	20	24⅞	Oc. 16, No. 10, 1931...Q 0.37½
Am. Sm. & Ref. 2nd pfd.	70	61	61	No. 6, De. 1, 1931....Q 1.50
Am. Sm. & Ref. 1st pfd.	102	98½	101	No. 6, De. 1, 1931....Q 1.75
Am. Zinc., L. & S.	5.00	2.75	4.00	May, 1917 1.00
Am. Zinc, L. & S., pfd.	32	23	32	October, 1930....Q 1.50½
Anaconda	18⅜	12⅜	15⅞	Jy. 11, Au. 17, 1931....Q 0.37½
Andes Copper	8.00	5.25	6.75	Ja. 10, Fe. 9, 1931....Q 0.25
Butte C. & Z.	1.87½	1.25	1.75	December, 1929 0.50
Butte & Superior	0.87½	0.75	0.87½	December, 1929....Q 0.50
Callahan Zinc-Lead	0.50	0.25	0.37½	December, 1920 0.50
Cal. & Hecla	5.25	3.50	4.62½	June, 1930 0.50
Cerro de Pasco Copper	17½	11½	15¼	Jy. 16, Au. 1, 1931....Q 0.25
Dome Mines	9.75	6.62½	9.00	Je. 30, Jy. 20, 1931....Q 0.25
Federal M. & S.	35	24	35	June, 1927 10.00
Federal M. & S., pfd.	51	50	50	My. 25, Je. 5, 1931....Q 1.75
Freeport Texas	22½	13½	21	No. 15, De. 1, 1931....Q 0.75
Granby Con	11	5.75	8.12½	Oc. 16, No. 2, 1931....Q 0.25
Greene Cananea	....	....	73½*	July, 1930 0.75
Homestake	111¼	95	110¼	Oc. 20, Oc. 26, 1931...M 0.65
Howe Sound	17	12½	15	Se. 30, Oc. 15, 1931...Q 0.50
Inspiration	6.00	3.25	5.00	July, 1930 0.50
International Nickel	10½	7.37½	9.00	Au. 31, Se. 30, 1931...Q 0.10
Int. Nickel, pfd	96	89	93½	Oc. 3, No. 2, 1931....Q 1.75
Kennecott Copper	16½	10½	13½	Se. 18, Oc. 1, 1931....Q 0.25
McIntyre Porcupine	18	12	17¾	No. 2, De. 1, 1931....Q 0.25
Magma Copper	11⅞	7.25	9.50	Se. 30, Oc. 15, 1931....Q 0.25
Miami Copper	4.50	3.00	4.00	August, 1930 0.375
Mother Lode	0.37½	0.25	0.37½	June, 1930 0.10
National Lead	97	84½	96	Se. 11, Se. 30, 1931....Q 1.25
National Lead, pfd. A	135	130	133	Au. 28, Se. 15, 1931....Q 1.75
National Lead, pfd. B	110	102½	102½	Oc. 16, No. 2, 1931....Q 1.50
Nevada Con	7.87½	5.00	6.12½	Se. 18, Se. 20, 1931....Q 0.20
Noranda Mines	15	10	14½	October, 1930 0.50
Park Utah Con	1.75	1.12½	1.50	July, 1929....Q 0.20
Patiño M. & E.	8.25	5.00	7.00	December, 1929 4s.
Phelps Dodge	9.87½	6.12½	8.50	Je. 18, Jy. 1, 1931....Q 0.25
Rand Mines	25	16	25	August, 1930 1.52
St. Joseph Lead	13½	9.25	12½	De. 10, De. 21, 1931...Q 0.25
Seneca Copper	0.50	0.37½	0.37½	....
Tennessee Corp.	3.25	2.62½	3.25	Fe. 28, Mh. 16, 1931...Q 0.125
Texas Gulf Sulphur	28½	20⅜	28	Se. 1, Se. 15, 1931....Q 0.75
U. S. S. R. & M.	18½	13⅜	17	Jy. 2, Jy. 15, 1931....Q 0.25
U. S. S. R. & M., pfd.	38	36½	38	Jy. 2, Jy. 15, 1931....Q 0.87½
Utah Copper	50	50	50	Se. 18, Se. 30, 1931....Q 1.50
Vanadium Corp.	22½	13½	19¾	Fe. 2, Fe. 16, 1931....Q 0.75
NEW YORK CURB EXCHANGE				
Aluminum Co. of Am.	87⅜	70	81½	....
Alum. Co. of Am., pfd.	84	75	79	Mr. 14, Ap. 1, 1931....Q 1.50
Anglo-Chilean Con	1.00	0.50	0.50	4 shares Cosach B...June, 1931
Bunker H. & S.	25⅜	23¼	24½	My. 29, Je. 5, 1931....0.25
Carnegie Metals	....	....	1.12½*	....
Comstock Tunnel	0.50	0.25	0.50	....
Con. Coppermines	1.50	1.00	1.12½	....
Copper Range	3.75	2.00	3.75	July, 1930 0.25
Cresson Consolidated	0.37½	0.15⅝	0.31¼	Je. 30, Jy. 10, 1931....Q 0.01
Cusi Mexicana	0.43⅛	0.37½	0.43⅜	....
Evans-Wallower	0.62½	0.56½	0.56½	....
Federated Metals	7.50	7.00	7.50	Ja. 5, Ja. 15, 1931....Q 0.25
Hecla Mining	5.00	4.00	4.37½	Au. 15, Se. 1, 1931....Q 0.10
Hollinger Consolidated	5.50	3.87½	5.50	Oc. 21, No. 4, 1931...M 0.05
Hudson Bay M. & S.	3.12½	2.00	2.62½	....
Iron Cap Copper	0.62½	0.62½	0.62½	....
Mayflower Associates	24½	22	24½	Se. 1, Se. 15, 1931....Q 0.50
Mining Corporation	1.37½	1.00	1.37½	December, 1929 0.12½
New Jersey Zinc	30⅜	26⅜	29¼	Jy. 20, Au. 10, 1931....Q 0.50
Newmont Mining	20½	14½	17½	Mh. 31, Ap. 15, 1931..Q 1.00
N. Y. & Honduras Ros.	13½	11½	13⅜	Jy. 21, Jy. 31, 1931....Q 0.25
Nipissing	1.25	1.00	1.25	Mh. 31, Ap. 20, 1931..Q 0.075
Ohio Copper	0.18⅛	0.12½	0.18⅜	September, 1926 0.03
Premier Gold	0.56½	0.37½	0.50	Je. 11, Jy. 3, 1931....Q 0.03
Quincy	3.00	2.00	3.00	March, 1920 1.00
Shattuck Denn	2.87½	2.00	2.12½	....
So. Am. Gold & Plat.	1.12½	0.87½	0.87½	....
Teck-Hughes	5.50	4.75	5.00	Jy. 18, Au. 1, 1931....Q 0.15
Tonopah Mining	....	....	0.50*	October, 1929 0.07½
United Eastern	....	....	0.06¼*	....
United Verde Ex.	6.00	5.00	5.25	Oc. 2, No. 2, 1931....Q 0.25
Utah-Apex	0.75	0.50	0.75	December, 1929 0.02
Yukon Gold	0.12½	0.12½	0.12½	June, 1918 0.02
BOSTON STOCK EXCHANGE				
Isle Royale	2.50	1.75	2.50	March, 1930 0.50
Mohawk Mining	17	11½	16½	Oc. 31, No. 28, 1931...Q 0.25
Old Dominion	2.25	1.50	1.62½	December, 1918 1.00
Utah Met. & Tunnel	0.35	0.15	0.35	December, 1927 0.30
MONTREAL				
Asbestos Corp.	....	....	0.25*	January, 1926 1.50
Asbestos Corp., pfd.	0.45	0.45	0.45	January, 1930 1.75
Consolidated M. & S.	0.65	0.65	0.65	Je. 23, Jy. 15, 1931....SA 1.25

Company Name	High	Low	Last	§Most Recent Dividend
SPOKANE				
Constitution	....	....	0.06½*	....
Dayrock	....	....	0.95*	March, 1930 0.03
Golconda	0.22	0.17½	0.18½	July, 1929 0.02
Jack Waite Con	0.26½	0.22	0.22½	....
Los Lugos	....	....	0.01½*	....
Mexican Premier	0.15	0.11½	0.11½	January, 1930 0.01
Montana Mines	....	....	0.09*	....
Noble Five	....	....	0.03*	January, 1930 0.005
Pend Oreille	0.85	0.65	0.80	....
Sherman Lead	....	....	0.31*	March, 1930 0.01
Sidney	....	....	0.05*	October, 1929 0.01
Sunshine Mining	1.12	0.95	1.05	December 20, 1930....Q 0.03
Tamarack & Custer	....	....	0.17½*	September, 1924 0.25
SALT LAKE CITY				
Chief Con	0.51	0.36	0.49½	February, 1928 0.10
Combined Metals	0.06½	0.05½	0.05½	....
Eureka Bullion	0.18	0.16	0.16½	....
Eureka Lilly	0.13	0.12	0.12½	....
Moscow Silver	0.40	0.38	0.40	....
New Quincy	....	....	0.13½*	September, 1929....Q 0.10
North Lily	0.80	0.65	0.73	January, 1930 0.15
Park Bingham	0.02½	0.01½	0.02½	....
Park City Con	0.17½	0.14½	0.14½	....
Rico Argentine	....	....	0.04*	December, 1929 0.03
Silver King Coalition	4.75	4.35	4.35	De. 20, Ja. 2, 1931....Q 0.15
Tintic Lead	0.95	0.80	0.95	....
Tintic Standard	3.50	3.25	3.40	Se. 18, Se. 30, 1931....Q 0.10
Walker Mining	1.05	0.89	0.96	April, 1930 0.075
¶ TORONTO				
Abana Mines	0.04	0.02½	0.03	....
Amulet Mines	0.18	0.14	0.16	....
Barry-Hollinger	0.10½	0.08	0.09	....
Base Metals	0.90	0.90	0.90	....
Canam Metals	0.02½	0.02½	0.02½	....
Castle-Trethewey	0.22	0.15	0.17½	....
Central Manitoba	0.08½	0.06½	0.08	....
Falconbridge	0.99	0.99	0.99	....
Granada Gold	1.40	1.15	1.40	....
Howey Mines	0.38	0.25	0.37	....
Keeley	0.26	0.21	0.21	March, 1928 0.04
Kirkland Lake	0.59½	0.52	0.58	....
Lake Shore	30	20	28½	Se. 1, Se. 15, 1931....Q 0.50
Sherritt Gordon	0.58	0.40	0.57½	....
Siscoe Gold	0.71	0.48	0.67	....
Sylvanite	0.70	0.59	0.67	De. 5, De. 20, 1930...SA 0.02
Treadwell Yukon	....	....	1.25*	....
Ventures	0.52	0.41	0.47	....
Vipond Con	0.66	0.50	0.60	April, 1927 0.03
Waite-A.-M.	....	....	1.00*	....
Wright-Hargreaves	3.05	2.22	2.95	Je. 15, Je. 30, 1931....Q 0.05
ST. LOUIS, CINCINNATI, AND DENVER				
Consolidated L. & Z.	1.25	1.00	1.25	December, 1929 0.125
Eagle-Picher	5.12½	4.75	5.00	April, 1930 0.20
Eagle-Picher, pfd.	....	....	89*	De. 31, Ja. 15, 1931....Q 1.50
Empire Chief	0.00⅜	0.00⅜	0.00⅜	....
Star of Utah	0.17	0.17	0.17	....
Tungsten Prod	....	....	0.11	....
Ute Gold	0.45	0.39	0.40	....
SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS				
California Copper	0.37½	0.25	0.25	....
(a) Golden Cycle	12½	11	11½	Au. 31, Se. 10, 1931....Q 0.40
(a) Granite Gold	0.17½	0.17	0.17	Je. 22, Jy. 1, 1931....Q 0.01
Idaho-Maryland	1.31	0.72½	1.13	....
Tom Reed	0.63	0.56	0.57	Je. 10, Jy. 1, 1931....Q 0.03
(a) United Gold	0.06½	0.05	0.05	Oct. 15, No. 1, 1931

‡ LONDON

Company Name	High	Low	Last	Most Recent Dividend (Per Cent, Unless Noted)
Anglo American	10/–	7/6	10/–	22½, Feb. 19, 1930
Aramayo Mines	17/6	14/4½	16/3	5, Oct. 23, 1929
Burma Corporation	9/4½	7/7½	8/7½	1¼, Dec. 10, 1930(b)
Camp Bird	6d	6d	6d	16¼, April 25, 1928
Fresnillo	....	....	8/9*	25 cents, Feb. 12, 1930
Frontino & Bolivia	12/–	11/3	11/3	2½, July 1, 1931
Lake View & Star	8/1½	7/3	7/9	11½, 1921
Mexican Corporation	1/9	1/3	1/6	10, Oct. 24, 1929
Oroville Dredging	1/1½	1/1½	1/1½	37½, May 16, 1930
Rhokana Corporation	87/6	55/–	85/–	....
Rhodes.-Select. Trust	9/–	6/6	8/6	....
Rio Tinto	395/–	320/–	355/–	10s, May 1, 1931
St. John del Rey	19/3	17/6	19/–	9d, No. 20, 1931
San Francisco Mines	11/3	5/9	8/–	10, Jan. 7, 1931
Santa Gertrudis	8/6	7/3	7/9	9d., July 9, 1931
Selukwe	1/9	1/3	1/6	6¼, April 2, 1917
So. American Copper	1/10½	7½d	1/–	....
Tanganyika	20/7½	15/7½	20/–	2½, Aug. 2, 1930
Wiluna Gold	8/4½	6/6	7/6	....
Union Minière	3,600	3,000	3,425†	240 francs, July, 1931

Salt Lake Stock Exchange courtesy J. A. Hogle & Company. ¶These figures are quoted in Canadian dollars. *Not traded in. †Belgian Francs. ‡The above London quotations are for the month ended Oct. 23. Q, quarterly; I, initial; M, monthly; X, extra; SA, semi-annual; L, liquidating B, plus bonus. §Total dividends paid during the month will be found tabulated in the Market and Financial News Section. Dates here given are those of closing of books and payment of dividend. (a) Bid prices. (b) 1¼% (2 annas) dividend, and bonus of ¼% (1 anna) (c) Closing bid prices.